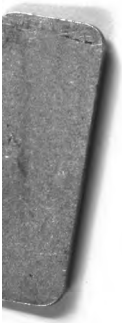

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DESCRIPTIVE LIST

FOR THE YEAR 1864,

OF

GENERAL MACHINERY,

MANUFACTURED BY

G. BUCHANAN & CO.,

Marine & Mechanical Engineers,

AND

MACHINERY MERCHANTS.

OFFICES:

25, BUCKLERSBURY, LONDON, E.C.

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GEORGE UNWIN, GRESHAM STEAM PRESS, BUCKLERSBURY, LONDON, E.C.

INTRODUCTION.

THE great difficulty experienced by non-professional men—whether merchants, proprietors of estates, the leading men of country towns and villages, and others—in obtaining even the roughest estimates of works which they may entertain an idea of carrying out, not only with reference to the use of machinery for manufacturing or other purposes, but also that required for sanitary purposes, such as the lighting or water supply of the places in which they or their correspondents reside, has unquestionably impeded, to a great extent, the introduction of improvements which otherwise might have been long since carried into execution.

It is well known to professional men that all improvements, whether in manufactories, private estates, or those of a public character, are very properly only decided upon after long and careful deliberation as to the probable cost, and the advantages of what is contemplated to be done. The determination to employ machinery, where it has not already been employed, or by those unaccustomed to its use, being one which is very cautiously and slowly arrived at. The following pages will form a most useful "Text Book" for all those requiring general information on the cost and capabilities of nearly all kinds of machinery and engineering works, including a short and, as far as possible, a popular exposition of the uses and capabilities, varieties of construction, and cost of four of the principal classes of machinery:—1st. Machinery employed in transmitting motion, or that which is properly placed under the head of Motive Powers or Prime Movers. 2ndly. Machinery employed in the transport of persons or merchandise, that is,

Steam Ships and Railway Plant. 3rdly. That employed for lifting weights, whether fluid or solid, embracing all descriptions of Cranes and Pumping Machinery. 4thly. Machinery employed in the formation of tools, and implied in the term Machine Tools.

To these several rather extensive subjects are added others of equal importance; viz., the cost and description of various classes of public works, as Gas and Water Works, Docks, Bridges, &c., as well as varied and highly useful information connected with some of the above subjects, although distinct from questions of use or cost—such as Rules for measuring the quantity of water flowing along streams, for the determination of the power available for the erection of hydraulic machines; Rules for calculating the approximate tonnage of ships, enabling those requiring vessels of a different capacity from those for which prices are given to arrive at the approximate cost of them. Also, statements of the probable cost of structures of brick or earth work necessary in determining the total cost of Gas and Water Works.

These subjects have necessarily been treated very briefly, and consequently at an occasional sacrifice of that exactitude necessary in making final and complete estimates for special machinery or public works; but yet, it is hoped, quite intelligibly; and, it is believed, with all the accuracy necessary or even desirable for the purpose intended, viz., machinery, plant, and works, in cases where general notions only are required, and where it is not necessary at starting to employ professional assistance, or where this cannot readily be obtained.

G. B. & Co. are actual manufacturers of about three-fourths of the machinery described in the following pages, contracting for the supply of other portions with houses devoting their time and capital to the perfection of specialities. In these cases, the prices are to be understood as strictly the same as would be charged by the manufacturers themselves to parties supplied direct by them. In the case of orders for machinery not manufactured by, but passing through the works of G. B. & Co., they become of course responsible for the quality and efficiency of the machinery or work supplied; and on this account take the utmost pains to ensure its perfection, as also to procure it alone from the first makers.

In many cases, such illustrations are annexed to the prices as will give

a general idea of the form of the machine, &c., referred to; the whole of the details having been carefully worked out and improved from time to time, as experience has dictated, so as to render the machines, as at present constructed, capable of being confidently offered to the notice of purchasers as efficient, simple, durable, and economical in price.

All the machines here quoted for have been proved highly efficient; similar machines have stood the test for many years' consecutive working, G. B. & Co. taking special care to recommend nothing that their own experience, or that of reliable witnesses, does not enable them confidently to pronounce both durable and effective.

G. B. & Co.'s Works being situated in the most favourable locality—both as regards cost of labour, coals, and materials—enables them to manufacture machinery upon the most economical scale; thus admitting of its being either better finished, or sold at a considerably reduced price, when compared with machinery manufactured by others whose works are not so favourably placed.

The prices quoted for all machinery, &c., contained in this Catalogue, includes packing and delivery in London or Liverpool.

TERMS.

The prices quoted are for Cash on delivery for machinery kept in stock; for that specially ordered, one-third to be paid on giving the order, one-third when the machinery is finished and ready for delivery, and the remainder when actually delivered according to the terms of the order.

MACHINERY FOR COLONIAL USE.

Amongst the machines constructed by G. B. & Co., and described in the following pages, will be found a large number specially designed for use in the Colonies, and of which they have had a most extensive manufacturing experience during the last 18 years. This class contains numerous machines which experience has proved to be highly useful, productive of unusual saving both in labour and expense in working, and which have been introduced into the Colonies solely by G. B. & Co.

Especial care is taken by G. B. & Co. that the Machinery manu-

factured by them for Colonial use is of the best description, and designed for working in localities where facilities for repairs do not exist. To this end many important modifications in the details of the machines are necessary, which, however, cannot easily be made apparent except by inspection.

ERECTING AND FIXING MACHINERY ABROAD.

When required, G. B. & Co. provide for the purchasers of their machinery, at a moderate charge, the services of an engineer or skilled workman to erect and set it to work. One-third of such charge to be paid on commencing the erection, and the remainder seven days after the machinery has been moved for the first time.

Should the purchaser require the services of the engineer for a short time beyond that necessary to complete the erection and starting of the machinery, his time will be charged at so much per day for any additional period.

SHIPPING AND INSURANCE, &c., OF MACHINERY.

When required, G. B. & Co. undertake to ship, insure and engage freight for all machinery ordered from them; and as they have had a large experience in this respect, they are enabled to make the most favourable arrangements.

MODE OF ORDERING, AND TERMS OF PAYMENT OF MACHINERY ORDERED FROM ABROAD.

Residents in the Colonies or foreign countries may order G. B. & Co.'s machinery through any respectable mercantile firm in Great Britain. The prices quoted are for Cash on delivery in London or Liverpool.

INDEX.

PART III.*—GENERAL MACHINERY.

The subjects treated of in this book are classified in the following order, viz.—

* Parts I. and II. are bound up together and published separately, price £

Part I.—Sugar Machinery.
Part II.—Coffee, Cocoa Nut, and Rice Machinery.

Other Prime Movers.

Chapter II.—Pile Driving Machinery.

Chapter III.—Dredging Machinery.

Chapter IV.—Iron Buildings and Materials for Fire-proof Buildings.

Chapter V.—Engineers' Tools, Foundry Fittings, &c.

Chapter VI.

Chapter VII.—Corn or Flour Mill Machinery.

Chapter VIII.—Brick-Making Machinery.

Chapter IX.

Chapter X.

Chapter XI.—Woodcutting Machinery.

Chapter XII.

Chapter XIII.—Pumps and Pumping Machinery.

Chapter XIV.—Cranes and Winches.

Chapter XVII.

Chapter XVIII.—Railway Plant.

Chapter XX.

Chapter XXI.—Water Works.

Chapter XXII.—Gas Works and Apparatus.

Chapter XXV.—Iron Vessels.

CHAP. I.—PRIME MOVERS.

STEAM ENGINES.

Steam engines may be conveniently classed under three heads;—1st, Those worked by low-pressure steam, which is afterwards condensed; 2nd, Those worked by high-pressure steam, which is exhausted into the atmosphere; and, 3rd, Those which are made with two cylinders of different sizes, the smaller being worked as a high-pressure engine, and the larger as a low-pressure one. The three classes of engines are usually known as—

1st. Condensing engines.
2nd. High-pressure or non-condensing engines.
3rd. High-pressure condensing engines.

The advantages of either of these classes of engines over the others depend upon the purposes for which they are required, the price of fuel, the supply of water, liability to change of position, and other considerations, including that of first cost.

Non-condensing engines are less economical in fuel than those of the other classes; but, as they have fewer parts and occupy less space, they are much used where simplicity, compactness, and economy of price are more important than economy of fuel. By a considerable expansion of the steam, however, these engines may be worked almost if not quite as economically as low-pressure condensing engines; but, in order that this may be carried out effectively, it necessitates their being fitted with separate expansion gear, which increases their cost.

The high-pressure condensing engines are the most economical in fuel of any of the classes, as they combine the advantages of working with high-pressure steam, as also those of condensing the same steam after considerable expansion. They are, however, the most expensive engines, and on this account alone are not so commonly employed in this country as the other kinds. In France and other places, where fuel is expensive, they are almost invariably preferred.

There are other modes of classifying engines besides that depending upon the peculiar mode of employing the steam in them. It is only necessary,

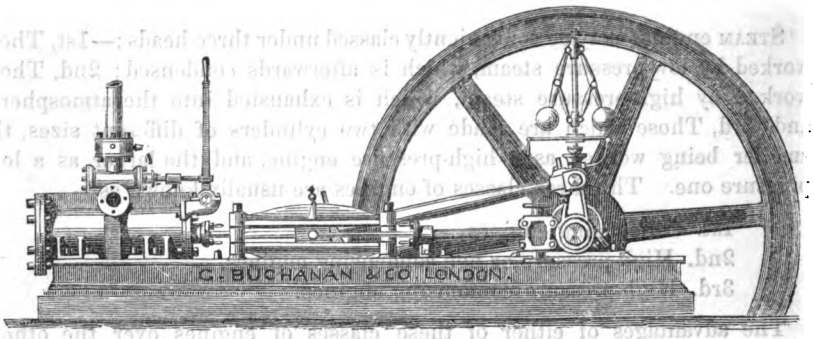
however, here to refer to that founded on the purposes to which they are applied; thus we have *stationary engines*, *portable engines*, *marine engines*, and *locomotive engines*.

The three last kinds will be found noticed under their separate heads. The following tables apply exclusively to the various kinds of stationary or fixed steam engines.

Ordinary Horizontal Non-condensing Engines.*

The advantages of these engines are *extreme simplicity*, great compactness, and easy access to all the working parts.

These engines usually work with steam of about 50 lbs. pressure, consuming about ¼ cwt. of best coals per H. P. in 10 hours. When required, they are fitted with heater, for heating the feed water by the waste steam.



The prices include fly wheel (which may be made to carry a driving belt), feed pump for supplying the boiler, governor, throttle and steam valves, and all usual pipes, connections, and fittings; also reversing gear for the larger sizes.

Horse Power.	Diameter of Cylinder, in inches.	Length of Stroke, in inches.	Revolutions per minute.	Price.	Extra if fitted with Heater for water feed.
4	6½	10	130	£	£
6	8	12	120	£	£
8	9½	14	110	£	£
10	10	15	110	£	£
12	11	16½	90	£	£
14	12	18	90	£	£
16	13½	20	85	£	£
20	14¾	22	60	£	£

Larger Engines at prices according to requirements.

* For prices and particulars of boilers suited to these engines see pages 31 to 42.

The foregoing engines are most suitable where the machinery to be driven has to move at a high velocity.

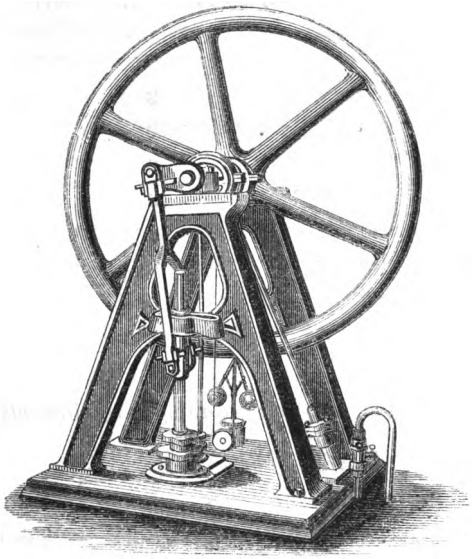
The following are prices and particulars of engines of the same class, but with longer strokes, and making fewer revolutions per minute.

Horse Power.	Diameter of Cylinder, in inches.	Length of Stroke.	Revolutions per minute.	Price.	Extra if fitted with Heater for feed water.
		ft. in.			
7	9	1 6	58	£	£
10	10	2 0	53	£	£
13	12	2 0	49	£	£
16	13	2 0	52	£	£
20	14	2 6	45	£	£
24	15	3 0	40	£	£
30	16½	3 0	40	£	£
40	19	3 6	36	£	£

Vertical Non-condensing Steam Engines.*

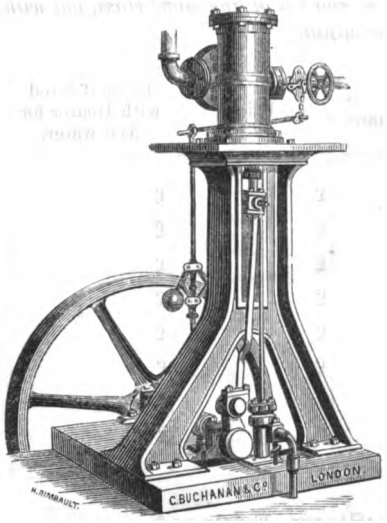
These engines are made in various forms, to suit the taste or requirements of those purchasing them; but the annexed illustrations show the kind most generally used.

A Framed Engine.

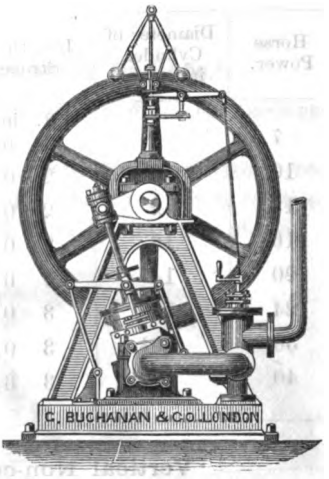


For prices and particulars of boilers suited to these engines see pages

OVERHEAD ENGINE.



OSCILLATING ENGINE.

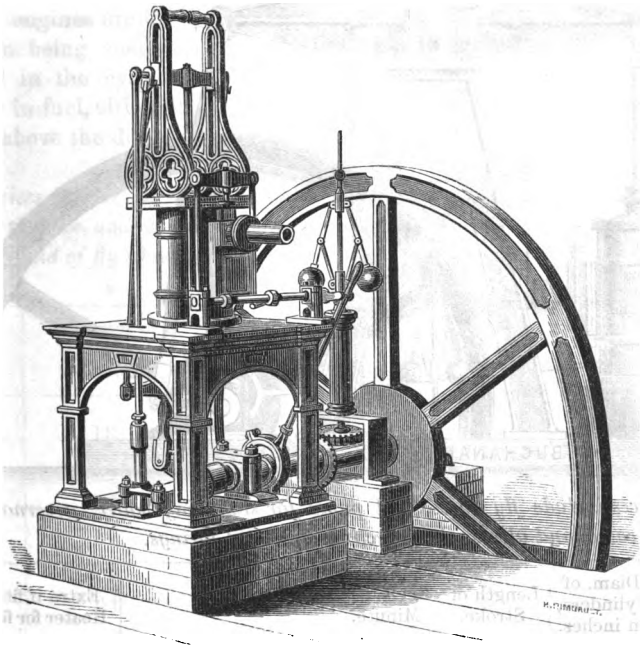


The prices include fly wheel, feed pump, governor, throttle and steam valves, and connecting pipes, all complete to outer end of fly wheel shaft.

Horse Power.	Diam. of Cylinder, in inches.	Length of Stroke.	Revs. per minute.	OVERHEAD ENGINE.	A FRAMED ENGINE.	OSCILLATING ENGINE.
4	6½	10	130	£	£	£
6	7¾	12	120	£	£	£
8	9	14	110	£	£	£
10	10	14	110	£	£	£
12	10¾	16	90	£	£	£
14	12	16	90	£	£	£
16	13	18	85	£	£	£
20	14½	24	60	£	£	£

Larger Engines at prices according to requirements.

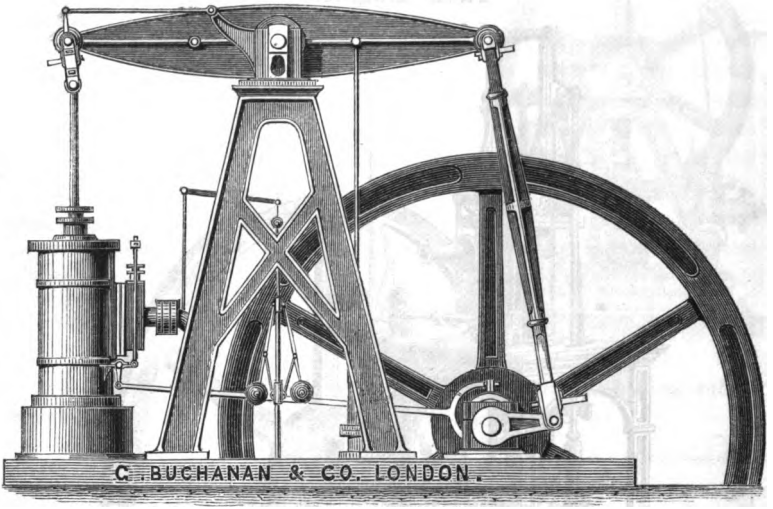
Table Engines.



Another class of engine, known as the "table engine," and in which the crank-shaft is near the sole-plate, the cylinder being placed upon a table or pedestal a little above it, may be had at about per cent. above the price of the overhead engines.

Non-condensing Slow-speed Beam Engines.*

These engines are highly approved, from their great durability and steadiness of working. They are necessarily more expensive than the engines before described, both from the greater number of parts, and also from the slow speed at which they revolve; but are preferred on account of the diminished speed making them less liable to wear. These engines are generally worked at about 50 lbs. pressure. They can be fitted with water heater if required.



The prices include fly wheel, feed pump for supplying boiler, governor, throttle and steam valve, and all usual connecting pipes and fittings.

Horse Power.	Diam. of Cylinders, in inches.	Length of Stroke.	Revls. per Minute.	Price.	Extra if fitted with Heater for feed water.
		ft. in.			
13	12	2 0	50	£	£
16	13	2 6	40	£	£
20	14	3 0	36	£	£
24	15	3 6	32	£	£
28	17	3 6	32	£	£
32	18	3 6	32	£	£
36	19	4 0	30	£	£
40	20	4 0	30	£	£
50	22	4 6	28	£	£

Larger Engines at prices according to requirements.

* For prices and particulars of boilers suited to these engines see pages

Ordinary Condensing Beam Engines.*

These engines are on the ordinary low-pressure principle, the pressure of the steam being moderate, viz., about 10 to 15 lbs. per square inch, slightly expanded in the cylinder and then condensed. These engines are very moderate in fuel, although, from the low pressure of steam, their consumption is much above the double cylinder engines hereinafter described.

The prices include fly wheel, feed and cold water pumps, air pump, condenser, governor, throttle and steam valves, and all usual connecting pipes and fittings, complete to end of fly wheel shaft.

Horse Power.	Diameter of Cylinder, in inches.	Length of Stroke.	Revolutions per Minute.	Price.
		ft. in.		
8	13	2 6	40	£
10	15	2 6	40	£
13	17	2 6	40	£
16	19	3 0	36	£
20	21	3 6	32	£
28	24	4 0	30	£
35	27	4 0	30	£
50	30	4 6	28	£
60	35	4 6	28	£

Larger Engines at prices according to requirements.

* For prices and particulars of boilers suited to these engines see pages

STEAM ENGINES FIXED ON BOILERS.

Small Engines of 2 and 3-horse Power.

(Working pressure of steam about 50 lbs. to the square inch.)

These engines are now extensively employed in the place of horses, for driving any small machinery. They possess all the advantages of fixed engines, without requiring any outlay for brickwork foundation. Being mounted on their own boilers, they can be placed in almost any position, and occupy but little room. The boilers are multitubular, very strongly made, and the fire boxes of Low Moor iron. The workmanship is all of the best description.

The price includes turned fly wheel, force pump, governor, and all the usual appendages.

Price of 2-horse power engine, as above ... ... £

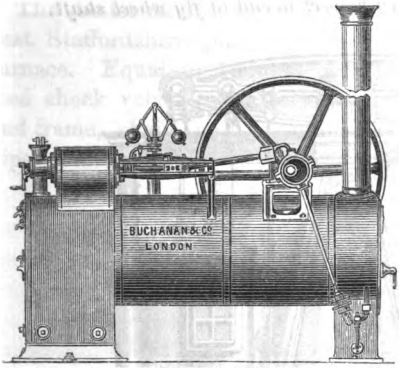
,, 3 ,, ,, ... £

Larger Sizes—Horizontal or Vertical.

These engines are of the same character as those last described, the engines being fixed to the boilers; but they are constructed either horizontal or vertical, according to the space allowed for them to stand in. As those last described, they require no brickwork foundation, and being perfect in themselves, they may be placed on the ground without preparation, or on board a barge. The vertical kind occupy the smallest possible ground space, and are well adapted for small shops or factories in towns, where space is of consequence.

G. B. & Co. have paid particular attention to this class of engines, and have generally a few in stock.

HORIZONTAL.



VERTICAL.

The price includes fly wheel (which may be made to carry a belt), governor, throttle and steam valves, feed pump, iron chimney, furnace fittings, and all the usual appendages.

Horse Power.	Diam. of Cylinder, in inches.	Price of Horizontal Form.	Price of Vertical Form.
4	6¼	£	£
6	7¾	£	£
8	9	£	£
10	10	£	£
12	10¾	£	£
14	12	£	£
16	13	£	£
20	14¼	£	£

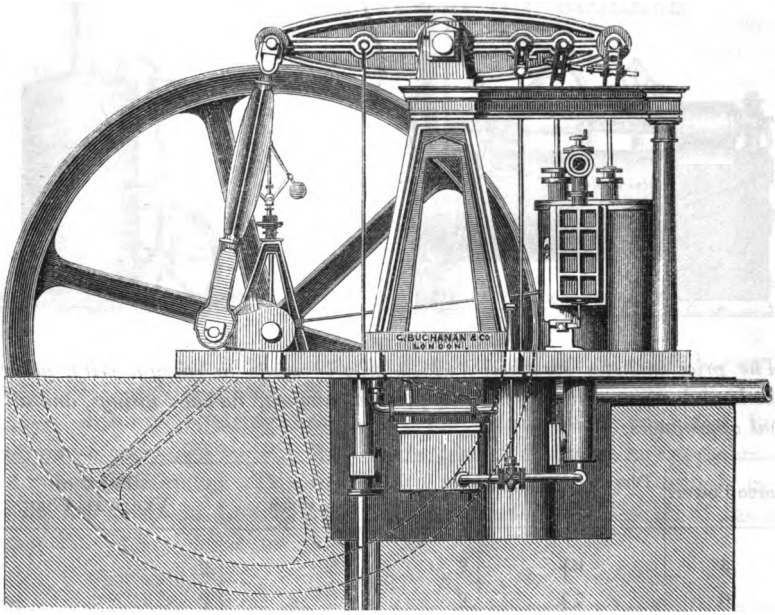
Double Cylinder High-pressure and Condensing Beam Engines

WITH BOILERS COMPLETE.

(Working pressure of steam from 30 to 50 lbs. per square inch.)

These engines are specially designed with the view of economising fuel, and are therefore admirably adapted for situations where fuel is expensive, but where tolerably careful management can be ensured. They are so constructed that steam of from 30 to 50 lbs. pressure per square inch can be used in the small cylinder, and afterwards expanded in the large one, finally passing into the condenser, and so giving the advantage of a vacuum. The consumption of coal in these engines, if carefully tended, should not much exceed half that of ordinary high-pressure engines.

These Engines are fitted complete in every respect to end of fly wheel shaft.



The following description of a double-cylinder engine, adapted for driving Flour Mill or other machinery, and lately constructed by G. B. & Co. for the Cape of Good Hope, will serve as a sample of this class of engine. They are made of any power required, the sizes of cylinders being proportioned to the pressure of steam intended to be used, and the degree of expansion desired.

SPECIFICATION OF 12-HORSE POWER DOUBLE CYLINDER HIGH-PRESSURE CONDENSING BEAM ENGINE, WITH BOILER COMPLETE.

Diameter of high-pressure cylinder, 11 in., and 2 ft. 3 in. stroke; that of low-pressure cylinder, 18¼ in., and 3 ft. stroke, fitted with metallic pistons, polished wrought-iron crank shaft. Fly wheel 14 ft. diameter, and weighing 78 cwt. Double parallel motion, governor, throttle and stop valves, cold water and feed pumps, fitted with gun-metal valves. Air-pump and condenser, with vacuum gauge (Boudon's patent). Hand-rail round fly wheel, and all the parts polished usual in engines of the first class. The whole secured to a substantial cast-iron foundation plate, and independent frame of modern design, and constructed of thorough good material and workmanship.

The boiler on the Cornish principle, with internal fire grate made of B best Staffordshire plate, ⅜-inch in thickness, with Lowmore plates over furnace. Equal to 16-horse power. Fitted with gun-metal safety valves, feed check valve, gauge cocks, glass water gauge, furnace fittings, damper and frame, chain, pulleys, and weight, together with all connecting steam pipes complete.

Price of engine and boiler, as above, complete... ... ... £

SUGAR MILL ENGINES,

WITH BOILERS.

These engines are specially designed for Colonial use, and for driving Sugar Cane Mills. They are constructed with very important modifications from ordinary engines, in having few parts, very heavy fly wheels, and are, moreover, so arranged as to require the least possible amount of repair. The horizontal engines are made with extra long strokes, thus diminishing the number of revolutions made by the crank shaft. This arrangement avoids the necessity of greatly reducing the speed by gearing for driving machinery required to move at a slow number of revolutions per minute. The non-condensing engines are worked with steam at 50 lbs. per square inch, and the condensing beam engines at from 15 to 20 lbs.

These engines are supplied with boilers considerably larger than those used in this country for engines of the same power, and are in other respects, besides those above mentioned, particularly recommended for Colonial use.

The boilers above 5-horse power have internal flues. All these engines work their steam expansively, in order to economise fuel. In those under 3 ft. stroke, the steam is sufficiently cut off by the ordinary slide valve; but in engines above that stroke, a separate expansive valve is recommended, but which increases the prices given for the engine about 10 per cent.

Non-Condensing Horizontal Steam Engines, with Boilers complete, specially constructed for G. B. & Co.'s Sugar Cane Mills.

The following particulars relate to the engines specially constructed by G. B. & Co. for driving Sugar Cane Mills of their own make, and adapted for use in the Sugar Colonies. They differ, as above stated, from the ordinary engines, in having larger boilers, and many other important points; a large supply of tools and materials for erecting and setting to work.

The prices quoted are for the engine complete in every respect to end of fly wheel shaft, including fly wheel, cold water and feed pumps, heater for feed water, governor, throttle and steam valves, boiler, with all furnace fittings and mountings complete; set of spare brasses, pump valves, spare check valve, half-set of bars, besides a large assortment of tools and materials for erecting abroad, and setting the engine to work.

Working pressure of steam, 50 lbs. per square inch.

Engines.				Boilers.					Price delivered in London.
Horse Power.	Diam. of Cylinder, in inches.	Length of Stroke.	Rev. per Minute.	Length.	Diam.	No. and Diam. of Flues.	
		ft. in.		ft. in.	ft. in.	No. in.	
7	9	1 6	58	12 0	3 6	1 18	£
10	10	2 0	53	13 0	4 0	2 15	£
13	12	2 0	49	15 0	4 6	2 17	£
16	13	2 0	52	17 6	4 9	2 19	£
20	14	2 6	45	17 0	4 9	2 23 (19½ ft. long)	£
24	15	3 0	40	20 0	5 0	2 23 (23 ft. long)	£
30	16½	3 0	40	23 0	5 3	2 24 (27 ft. long)	£
40	19	3 6	36	29 0	6 0	2 26 (33 ft. long)	£

NOTE.—The four last sizes have boilers on the French system.

Engines and Boilers of greater power, according to requirements.

Long-stroke Slow-speeded Non-Condensing Horizontal Steam Engines, with Boilers complete.

Working pressure of steam, 50 lbs. per square inch. The price quoted is for the engine complete to end of fly wheel shaft, with all usual pipes, connections, &c., and includes all the parts described as belonging to G. B. & Co.'s Sugar Mill Engines; also, boiler with mountings and fittings complete. The prices include a set of spare parts, but are exclusive of any tools and materials for erection and setting to work.

Engine.				Boiler (cylindrical).					Price delivered in London.
Horse-Power.	Diam. of Cylinder, in inches.	Length of Stroke.	Revols. per Minute.	Length.		Diam.		No. and Diam. of Flues.	
		ft. in.		ft.	in.	ft.	in.	No. ins.	
2	5	1 0	80	7	0	2	6	No flue	£
3½	6	1 0	80	11	6	2	6	—	£
5	7	1 6	60	11	6	3	6	—	£
6½	8	1 6	60	16	6	3	6	—	£
8	9	2 0	50	16	6	4	0	—	£
10	10	2 0	50	14	0	4	0	1 18	£
12	11	2 6	40	16	6	4	6	1 20	£
15	12	2 6	40	19	0	4	6	1 21	£
18	13	3 0	36	21	3	4	6	1 22	£
22	14	3 0	36	23	6	4	6	1 22	£
26	15	3 6	32	26	0	4	9	1 22	£
30	16	3 6	32	27	6	5	0	2 18	£
35	17	4 0	30	32	0	5	3	2 19	£
40	18	4 0	30	35	0	5	3	2 19	£

Engines and Boilers of greater power at prices according to requirements.

These engines are of the same description as the last named, the proportions being somewhat altered, so as still further to reduce the number of revolutions of the fly wheel shaft.

Non-Condensing Beam Steam Engines,

WITH BOILERS COMPLETE.

These engines differ in construction from the ordinary non-condensing beam engines, in the particulars already noticed—viz., by having heavier fly wheels, larger boilers, and in some other important respects.

The prices quoted are for the engine complete to end of fly wheel shaft, including all the parts described as fitted to G. B. & Co.'s Sugar Mill Engines; also boiler, with all usual mountings and fittings. The prices also include set of spare pieces, but are exclusive of any tools or materials for erecting and setting to work, which will be furnished on application.

Engine.				Boiler (cylindrical).				Prices delivered in London.
Horse-Power.	Diam. of Cylinder, in inches.	Length of Stroke.	Revols. per minute.	Length.	Diam.	No. and Diam. of Flues.		
		ft. in.		ft. in.	ft. in.	No. in.		
13	12	2 0	50	16 6	4 6	1 20	£	
16	13	2 6	40	19 0	4 6	1 21	£	
20	14	3 0	36	21 3	4 6	1 22	£	
24	15	3 6	32	23 6	4 9	1 24	£	
28	17	3 6	32	27 6	5 0	2 18	£	
32	18	3 6	32	32 0	5 3	2 19	£	
36	19	4 0	30	35 0	5 3	2 19	£	
40	20	4 0	30	Two 20 0	5 3	2 19	£	
50	22	4 6	28	Two 25 0	5 3	2 19	£	
65	24	4 6	28	Two 32 0	5 3	2 19	£	

Note.—The three last sizes have boilers on the French system.

Engines and Boilers of greater power, at prices according to requirements.

Condensing Beam Steam Engines,

WITH BOILERS COMPLETE.

These engines are peculiarly well suited for driving Sugar Mills, or for Colonial use. They are economical in fuel, very steady in working, and possess the same advantage as the high-pressure beam engines, in having the cylinder vertical, thus avoiding the possibility of uneven wear. These engines differ from the ordinary kind, in having larger boilers, heavier fly wheels, and in other important respects. They usually work with steam power of from 10 to 15 lbs. pressure.

The prices quoted are for the engine complete to end of fly wheel shaft, including fly wheel, governor, throttle and steam valves, boiler, with all usual fittings and mountings; also set of spare pieces, but are exclusive of tools and materials for erecting and setting to work.

Engine.				Boiler (cylindrical).			Price, delivered in London.		
Horse-Power.	Diam. of Cylindr.	Length of Stroke.	Rev. per Minute.	Length.	Diam.	No. and Diam. of Flues.	Engine.	Boiler, with Fittings.	Total.
	in.	ft. in.		ft. in.	ft. in.	ft. in.			
8	13	2 6	40	14 0	3 9	No flue	£	£	£
10	15	2 6	40	14 0	3 9	1 16	£	£	£
13	17	2 6	40	16 6	4 0	1 18	£	£	£
16	19	3 0	36	16 6	4 6	1 20	£	£	£
20	21	3 6	32	19 0	4 9	1 22	£	£	£
28	24	4 0	30	23 6	4 9	2 16	£	£	£
35	27	4 0	30	26 0	5 0	2 18	£	£	£
50	30	4 6	28	30 6	5 3	2 19	£	£	£
60	35	4 6	28	Two 23 6	4 9	2 16	£	£	£

Engines and Boilers of greater power, at prices according to requirements.

STEAM BOILERS.

The proper construction of steam boilers forms one of the most important parts of engineering practice, and great attention has been paid, especially of late, to this subject, mainly from the fact that boilers are now employed to generate steam at a much higher pressure than formerly. This change has arisen partly from the increasing knowledge that the higher the pressure of the steam used (other things being equal), the greater has been the economy of fuel, partly from the greater ease with which boilers for sustaining high-pressure steam are made now than formerly, and partly from an increasing desire on various accounts to lessen the weight of boilers, and the space occupied by them. With respect to the space occupied by boilers of different construction, a very great difference exists. The following tables give their relative capacities, the total heating surface being equal in all cases. For example:—one square foot of heating surface, in a plain cylindrical boiler, requires about 35 cubic feet of boiler room; whereas, one square foot of heating surface of a locomotive boiler only requires one cubic foot of boiler room, and so of other kinds of boilers, according to the following table:—

Cylindrical Boilers, without internal flues	...	35 feet.
„ „ with one internal flue	...	16 „
„ „ with two internal flues	...	10 „
Marine Boilers	...	5 „
Locomotive ditto	...	1 „

The main considerations which determine the choice of any particular boiler are, first, the space it occupies; secondly, its weight; thirdly, its construction, if for export, as regards easy transport and shipment; fourthly, its economy in fuel; fifthly, its capability for rapidly raising steam; sixthly, its durability; seventhly, its construction, both as regards its strength to sustain pressure, and the amount of care required to work it with safety, by maintaining the proper water level.

The boilers manufactured by G. B. & Co. are of the best plate, those directly exposed to the action of the fire being of Low Moor or Bowling iron.

All the boilers noticed in the following tables (except the waggon boilers) are suited for steam about 60 lbs pressure per square inch, being proved by hydraulic pressure to 100 lbs. per square inch. The waggon boilers are intended for steam at 10 lbs. pressure, and the locomotive boilers for steam at 100 lbs. working pressure. Boilers required for pressures not exceeding 20 lbs. per square inch would be somewhat less in price, being made of plate one-sixteenth less in thickness.

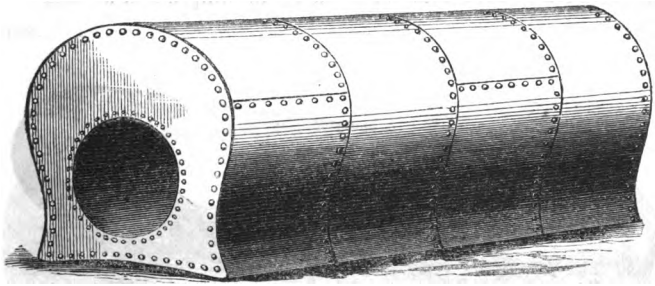
Boilers required to work at more than 60 lbs. would be charged at a somewhat higher price, the boilers being heavier stayed, and the flues, &c., proportionally strengthened.

NOTE.—In the following tables it must be understood that, for the waggon boilers, the pressure of steam being low, and the engines supplied by them not usually much exceeding their nominal horse-power, Boulton and Watts' rule of from 15 (for small) to 9½ (for large boilers) square feet of total heating surface per nominal horse-power is allowed. All other boilers are reckoned to contain 14 square feet of total heating surface per nominal horse-power.

The price includes brackets (when required) for supporting the boilers, man hole, and door. The price of furnace fittings, as well as mountings, are given separately. These include furnace door and frame, one and a half-set of furnace bars, bearer bar, dead plate, damper door and frame, with weights, pulleys, and chain. Steam chest, safety valve, glass water gauge and spit cocks, blow-off pipe and cock, and steam gauge.

Waggon Boilers.

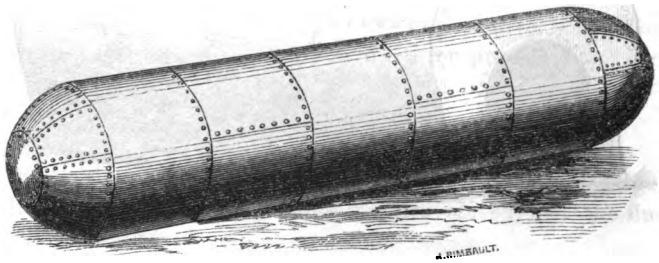
These boilers are very convenient for low-pressure steam not exceeding 10 lbs. per square inch, and are very efficient, economical, and durable. For powers above 20 horses, they are fitted with an internal flue, in which case they are known as "Boulton and Watt" boilers. The boilers without internal flues have the advantage of not requiring such strict attention to the level of the water being uniformly maintained.



Horse-Power.	Length.	Breadth (greatest).	Depth (greatest).	Size of Central Flue.	Price.	Price of Furnace Fittings and Boiler Mountings, as specified at page 32.
	ft. in.	ft. in.	ft. in.			
2	4 6	3 2	4 1	none	£	£
3	5 3	3 4	4 4	,,	£	£
4	6 0	3 6	4 7	,,	£	£
6	7 0	3 9	5 1½	,,	£	£
8	8 0	4 0	5 6	,,	£	£
10	9 0	4 3	5 9½	,,	£	£
12	10 0	4 6	6 0	,,	£	£
14	10 0	4 9	6 2½	,,	£	£
16	11 9	5 0	6 6	,,	£	£
18	12 8	5 2	6 8	,,	£	£
20	13 6	5 4	6 10	,,	£	£
30	16 0	5 6	7 6	2 6 dia.	£	£
45	19 0	6 0	8 6	3 0 ,,	£	£

Cylindrical Egg-ended Boilers.

These boilers are of the simplest possible construction, and where the space they occupy is not of material consequence, and the difficulty of getting repairs made is great, they are desirable. Considerable variation in the level of the water may occur without endangering the safety of the boiler, there being no flues or tubes to leave uncovered, as in some other kinds. If of large size, and consequently difficult to ship in one piece, the rivetting together of the two halves is easily accomplished abroad.



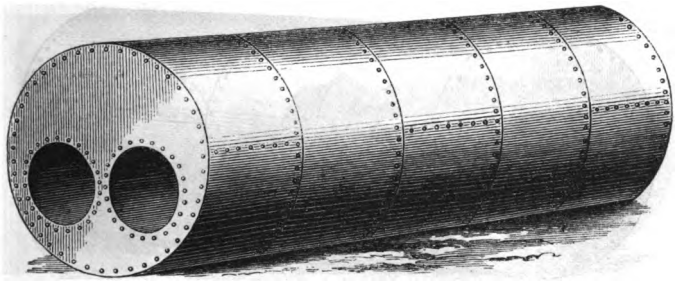
Horse-Power.	Length.		Diameter.		Price.	Price of Furnace Fittings and Boiler Mountings, as before specified.
	ft.	in.	ft.	in.		
4	13	0	2	9	£	£
6	18	0	3	0	£	£
8	20	0	3	3	£	£
10	25	0	3	6	£	£
12	28	0	3	9	£	£
14	29	0	4	0	£	£
16	31	0	4	3	£	£
20	32	0	4	6	£	£
25	37	0	4	9	£	£
30	44	0	5	0	£	£

Cylindrical Boilers, with Internal Flues.

(Flued Boilers, fired from beneath.)

These boilers are, like the plain cylindrical boilers, very simple in their construction, only having the addition of one or two flues, which increases the heating surface, so allowing of the boiler being made shorter, the flame first passing along the bottom of the boiler, and then back through the flues. Boilers on this plan, if of large power, can frequently be shipped entire, where it might be necessary to divide a plain cylindrical one.

These boilers are usually more economical in fuel than the plain cylindrical ones.

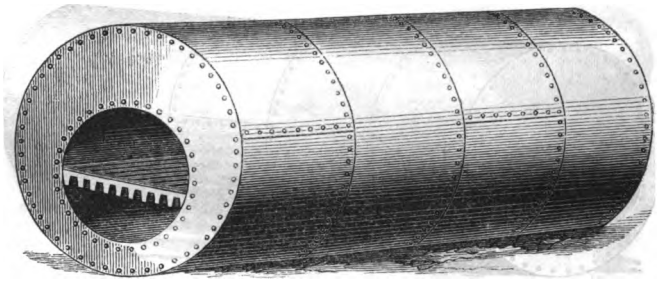


Horse-Power.	Length.		Diam. of Cylindrical Shell.		No. and Diameter of Flues.		Price.	Price of Furnace Fittings & Mountings, as specified at p. 32.
	ft.	in.	ft.	in.	No.	in.		
4	7	0	2	9	1	15	£	£
5	8	0	3	0	1	16	£	£
6	9	0	3	3	1	17	£	£
8	11	6	3	6	1	18	£	£
10	13	0	3	9	1	19	£	£
13	13	0	4	0	2	15	£	£
15	14	0	4	3	2	16	£	£
20	17	6	4	6	2	17	£	£
25	20	0	4	9	2	19	£	£
30	23	0	5	0	2	20	£	£
35	25	0	5	6	2	21	£	£
40	27	0	6	0	2	22	£	£

Cylindrical Boilers, with Internal Furnaces.

(CORNISH BOILERS.)

These boilers are exceedingly compact, without being in any way complicated. They are made with single or double flues, according to diameter. The brickwork setting of these boilers is very simple, merely enclosing the boiler, and forming external flues. The same remarks as regards easy shipment apply to these boilers as to the last.

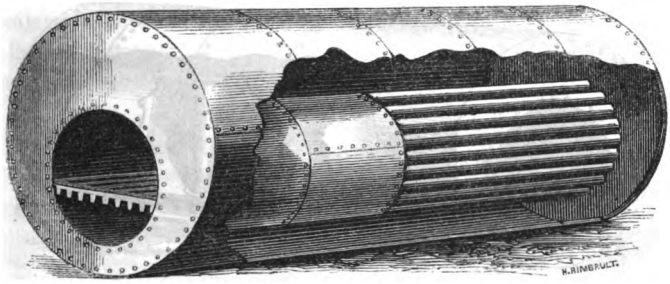


Horse-Power.	Length.		Diameter.		No. and Diameter of Flues.		Price.	Price of Furnace Fittings and Mountings, as specified at page 32.
	ft.	in.	ft.	in.	No.	ft.		
6	7	0	3	6	1	2	£	£
9	10	0	4	0	1	2¼	£	£
12	12	0	4	0	1	2½	£	£
15	14	0	4	0	1	2½	£	£
18	14	6	5	0	1	3	£	£
20	16	6	5	0	1	3	£	£
25	19	0	5	6	1	3	£	£
35	21	0	6	0	2	2¼	£	£
40	24	0	6	0	2	2¼	£	£
50	30	0	6	0	2	2¼	£	£

Cylindrical Boilers, with Internal Furnace and Tubes.

(CORNISH TUBULAR BOILERS.)

These boilers, unlike those before described, are intended to be worked *without* brickwork setting, there being sufficient heating surface *within* the boiler to generate the required quantity of steam. The shells of the boilers may be felted and lagged, if required, to prevent radiation of heat. These boilers occupy but little space, and are very convenient for removal. They are made with single and double furnaces, according to size, and have usually iron smoke boxes and chimneys, but these parts may of course be of brickwork if preferred. The water-level in these, as well as in all tubular boilers, should be carefully maintained, as the tubes, if left uncovered, are very soon destroyed.



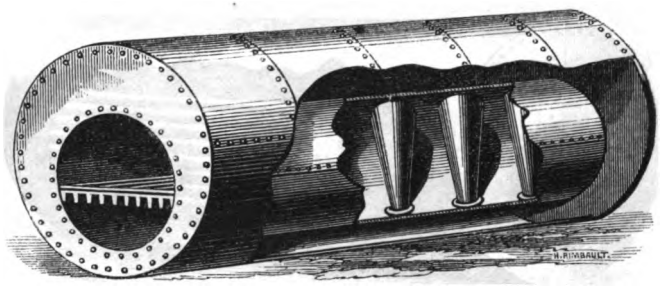
Horse-Power.*		Length.		Diamr.		No. and Diameter of Furnace Flues.			No. and Length of Small Tubes, 2 inches Diameter.			£ Price.	Price of Fittings and Mountings, as before specified.	Price of Iron Chimney and Smoke Box.
If set in brick-work.	If worked without brickw. setting.	ft.	in	ft.	in.	No.	ft.	in.	No.	ft.	in.			
12	9	7	0	3	6	1	2	0	56	3	6	£	£	£
20	16	10	0	4	0	1	2	3	70	5	0	£	£	£
28	23	12	0	4	0	1	2	6	88	6	0	£	£	£
32	26	14	0	4	0	1	2	6	88	7	0	£	£	£
44	36	14	0	5	0	1	3	0	126	7	0	£	£	£
54	44	17	0	5	0	1	3	0	126	8	6	£	£	£
60	48	18	0	5	6	1	3	0	126	9	0	£	£	£
77	63	21	0	6	0	2	2	3	140	10	6	£	£	£

* Two lists of powers are given for these boilers, the one answering to the capabilities of the boilers if set in brickwork in the ordinary way, in which case half the outer shell becomes heating surface; and the other, where the boilers are worked without any brickwork setting, no part of the outside of the boilers being reckoned as heating surface.

Cylindrical Boilers, with Internal Furnaces, and short Vertical, Conical Tubes.

(GALLOWAY BOILER.)

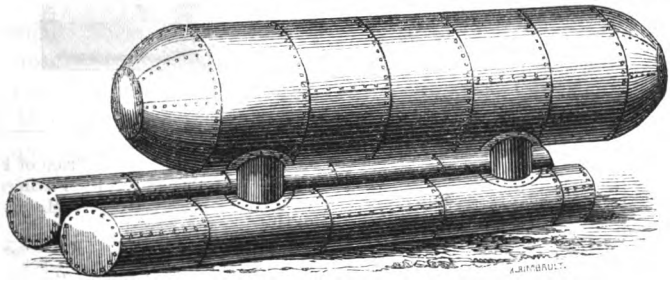
They are much used in Cotton Factories, and are much approved of, occupying for their power comparatively little space. They are also easily repaired. The flue is well supported, by the conical tubes passing through it. These boilers are considered to be very economical in fuel.



Hrs. Pwr.	Length.	Diam.	No. and Mean Dia. of Furn.	Mean Dia. of After-flue.	No. and Diam. of Cones.	Price.	Ext. for Furn. Fittings and Boiler Mountgs.
	ft. in.	ft. in.	ft. in.	ft. in.	No. in.		
24	18 0	4 6	1 32	2 8	14 6	£	£
30	20 0	5 0	1 36	3 0	14 7	£	£
45	22 0	5 6	2 26	2 8	14 8	£	£
53	24 0	6 0	2 29	2 11	14 9	£	£
63	26 0	6 6	2 31	3 2	14 10	£	£
75	28 0	7 0	2 33	3 6	14 11	£	£

French, or Elephant Boilers.

The objects attained in this construction of boiler are mainly those of saving space, and of allowing a good pressure of steam being employed, as the diameter of the shell need not be large. The tubes are not placed within the boiler, but outside it, and have water inside of them, being surrounded by the flame. The water tubes are made large enough for a lad to enter them, their ends being brought out to the face of the masonry. This class of boiler being easily divided into three portions—viz., the shell and the two water tubes, are especially suited for boilers of considerable power for exportation. The water tubes are connected to the shell by short connecting tubes, these being easily rivetted to the shell from the inside of the latter. These boilers have been adopted by G. B. & Co., after long experience, for the larger sizes of their steam Sugar Mills, and have given great satisfaction.

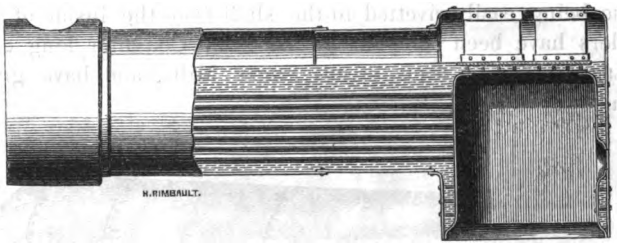


Horse-Power.	Length of Shell.	Diameter of Shell.	Diameter and Length of Water Tubes.			Price.	Price of Furnace Fittings and Mountings.
			No.	Dia.	Length.		
	ft. in.	ft. in.		in.	ft. in.		
24	17 0	4 9	2	23	20 0	£	£
28	20 0	5 0	2	23	23 0	£	£
34	23 0	5 0	2	24	26 0	£	£
40	26 0	5 3	2	24	29 0	£	£
45	29 0	5 3	2	25	32 0	£	£
50	32 0	5 6	2	25	35 0	£	£

Locomotive Boilers.

(With small Tubes, stayed Fire-box, Smoke Box, and Funnel.)

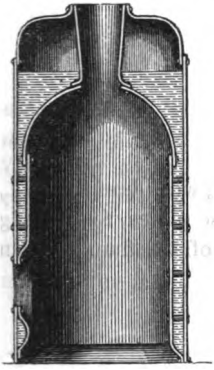
These boilers are adopted, as is well known, in cases where very great power is required to be put into a small space. The high generating power of the fire-box, coupled with the large surface presented by a great number of small tubes, render their power for getting up steam in a short time very great. When the draught of these boilers is assisted by a jet of steam, they become the most powerful steam generators which can perhaps be constructed.

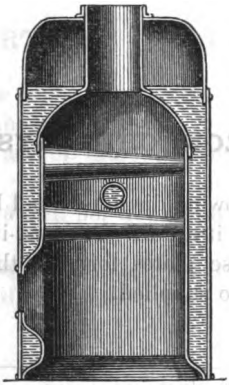


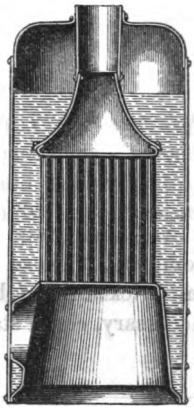
Hrs. Pwr.	Total Lngths.	Dia. of Cyldcl. Shell.	Length of Tubes.	No. of Tubes 2 in. Diam.	Size of Fire Box.		Price.	Price of Furnace Fittings and Mountings.
					Brdth.	Lngth.		
	ft. in.	ft. in.	ft. in.		ft. in.	ft. in.		
8	9 9	2 0	5 6	30	2 6	2 0	£	£
10	10 9	2 3	6 0	38	2 9	2 3	£	£
13	11 6	2 6	6 6	46	3 0	2 6	£	£
15	12 6	2 9	7 0	56	3 3	2 9	£	£
21	13 3	3 0	7 6	66	3 6	3 0	£	£
25	14 3	3 3	8 0	78	3 9	3 3	£	£
30	15 0	3 6	8 6	90	4 0	3 6	£	£
38	16 0	3 9	9 0	104	4 3	3 9	£	£
46	16 9	4 0	9 6	118	4 6	4 0	£	£
55	17 9	4 3	10 0	134	4 9	4 3	£	£
64	18 6	4 6	10 6	150	5 0	4 6	£	£

Vertical Boilers.

(With Iron Chimney complete.)







These boilers are exceedingly handy where the ground space is confined, and they also save the expense and trouble of an ordinary brickwork setting. They may stand up in any corner of a factory, quite out of the way, only requiring room for stoking on one side. There are three kinds of vertical boilers—1st. Those with large fire boxes, without flues and tubes; 2nd. with large fire boxes, and conical cross tubes; and, 3rd. ordinary fire boxes, with vertical tubes above. The advantages of one construction over the other is not great, the boiler with plain fire box being the most simple, but generally not quite so economical in fuel as the other kinds. The difference of these boilers in size for the same power is however considerable. The heights and diameter of all boilers of the same power, on the three plans above described, are given in the following table. All these boilers being of small diameter, are calculated to work with 50 to 100 lbs. pressure.

Horse-Power.	Boiler with Plain Fire Box. No. 1.		Boiler with Cross Conical Tubes No. 2.		Boiler with Small Vertical Tubes No. 3.		Price of No. 1 Boiler.	Price of No. 2 Boiler.	Price of No. 3 Boiler.	Average Price of Furnace Fittings and Mountings, as above specified.
	Hght.	Dia.	Hght.	Dia.	Hght.	Dia.				
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.				
2	5 6	2 6	4 6	2 0	4 0	1 9	£	£	£	£
3	7 0	3 0	5 6	2 6	4 6	2 0	£	£	£	£
4	8 0	3 6	7 0	3 0	5 0	2 3	£	£	£	£
5	9 0	4 0	7 6	3 3	5 6	2 6	£	£	£	£
6	10 0	4 0	8 0	3 6	7 0	3 0	£	£	£	£
7	10 6	4 6	8 6	3 9	7 0	3 3	£	£	£	£
8	11 0	5 0	9 0	4 0	7 6	3 3	£	£	£	£
10	12 6	5 6	10 6	4 6	8 0	3 6	... ...	£	£	£

The powers and dimensions of boilers given in these tables are those more frequently used, higher powers being made up by two or more boilers. G. B. & Co., however, manufacture boilers of any other suitable sizes and proportions, to answer special requirements.

IRON CHIMNEYS

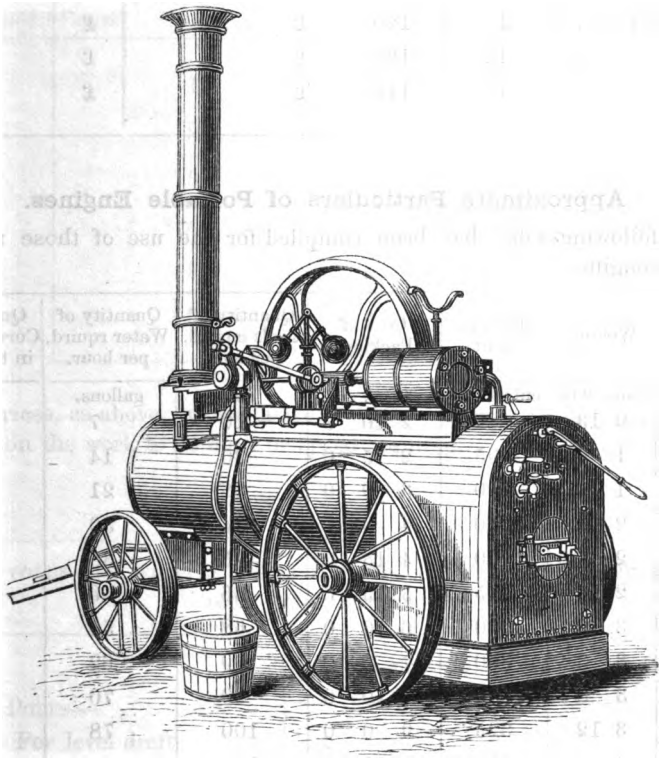
Are constructed of the following diameters and heights, with dampers, &c., complete. Those requiring it are fitted to cast-iron base plates, for resting on brickwork of boiler, these plates forming the top of the flue. When necessary, chain stays are also supplied.

Horse-Power of Boiler to which applied.	Length of Chimney.	Diameter of Chimney.	Price of Chimney.	Extra for Cast-iron Base Plate.
	feet.	inches.		
4	25	11	£	£
6	25	13	£	£
8	25	15	£	£
10	30	17	£	£
12	30	18	£	£
14	30	20	£	£
16	35	21	£	£
18	35	22	£	£
20	35	23	£	£
25	40	24	£	£
30	40	26	£	£
35	40	28	£	£
40	45	30	£	£
45	45	31	£	£
50	45	33	£	£
55	50	35	£	£
60	50	36	£	£
65	50	38	£	£

PORTABLE ENGINES.

These engines have now come into such extensive use, that a detailed description of them and their advantages is not here necessary. Those supplied by G. B. & Co. are of thorough good finish and workmanship. Wood may be used as fuel. If coal is used, one of these engines of six-horse power will burn only about 5 cwt. per day of twelve hours.

The fly-wheel of these engines is made for carrying a driving belt, but a small pulley may be added if required.



These engines are furnished with governor, feed pump, steam and water gauges, furnace, and all other usual fittings.

Horse-Power.	Diam. of Cylinder.	Length of Stroke.	Revols. per Minute.	Price.	Extra if fitted with Iron instead of Wooden Wheels.
	inches.	inches.			
2	4½	8	180	£	£
3	5½	9	160	£	£
4	6¼	10	130	£	£
5	7	12	120	£	£
6	7¾	12	120	£	£
7	8½	12	120	£	£
8	9	12	120	£	£
10	10	14	110	£	£
12	12	16	90	£	£
10	Two 7	12	120	£	£
12	,, 7¾	12	120	£	£
14	,, 8½	14	110	£	£

Approximate Particulars of Portable Engines.

The following table has been compiled for the use of those requiring portable engines.

Horse-Power.	Weight.	Measurement.	Cost of Packing.	Quantity of Coals cnsmd. per hour.	Quantity of Water rquird. per hour.	Quarters of Corn thrashed in ten hours.
	Tns. cwts.	cubic feet.	£ s. d.	lbs.	gallons.	
1	0 13	85	2 10 0	10	7	10
2	1 4	195	2 15 0	20	14	20
3	1 10	220	3 0 0	28	21	30
4	2 0	240	4 0 0	34	30	40
5	2 6	260	4 15 0	45	38	50
6	2 12	275	5 15 0	56	46	60
7	3 0	290	6 10 0	68	54	70
8	3 3	300	7 5 0	79	62	80
9	3 8	315	8 10 0	90	70	90
10	3 12	325	9 0 0	100	78	100
12	4 0	340	10 0 0	120	94	120
14	4 10	360	11 5 0	140	110	140

HORSE WORKS.

For communicating cattle-power to any kind of machinery, and at any speed required. The diameter of the cattle track is 28 feet, which, at two miles per hour, gives just two circuits for the cattle per minute. In all sizes of horse work, the whole upper part is formed of iron, a timber curb or frame being staked to the ground or block of masonry, upon which frames the horse works are placed.

The prices include all bevel gear and connecting shafting, with plummer blocks, holding down bolts, and, where necessary, draft poles, and stays, complete.

No. of Cattle.	Price.
1	£
2	£
3	£
4	£
5	£
6	£

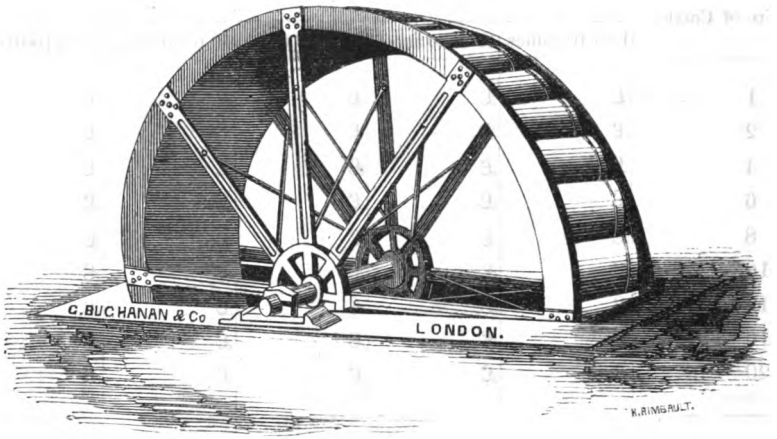
The prices, as above, are exclusive of intermediate gear, the cost of which depends on the work to be done or speed required.

DRAFT POLES AND WHIPPLE TREES FOR THE ABOVE, WITH ALL NECESSARY IRON WORK, COMPLETE.

	For single beast.	For pair.
DRAFT POLES—		
For level draft	£	£
For overhead ditto ...	£	£
WHIPPLE TREES	£	£

WATER WHEELS.

Vertical water wheels are usually divided into three classes—overshot, breast, and undershot wheels, each kind possessing advantages over the others in special cases. As it is highly important for users of these machines to know under what conditions each of these wheels can best be employed, the following notes are given :—



Overshot Wheels,

Where the water is brought over the wheel, and laid on the opposite side.

The efficiency of overshot water wheels is greater than either breast or undershot wheels, the power given out being equal to about three-fourths of the actual power of the water. These wheels are fed by a spout, at or a little below the summit. If with unventilated buckets, they may be fed at the summit; if with ventilated buckets, at about one-tenth of the diameter below the summit. The fluctuation in the level of the water in overshot wheels should not be more than a foot.

The best speed for the periphery of an overshot wheel is about 6 feet per second, but if the machinery to be driven render it desirable to alter this, it may be done without much loss, within certain limits—viz., not below 4 feet, or much above 8 feet per second.

The velocity of the water, when it meets the wheel, should be *double* that of the periphery of the wheel; consequently, in calculating the effective fall, to get at the diameter of the wheel, a deduction should be made from the *total* fall sufficient to get up the velocity of the water before it meets the wheel. If the wheel travels at 6 feet per second, about 2¼ feet should be allowed; if at 4 feet per second, about 1 foot; and if at 8 feet per second, about 4 feet. The *diameter* of an overshot water wheel should therefore not be less, nor need it be more, than the total fall, less 1, 2¼, or 4 feet respectively, according to speed; with ventilated buckets, as before observed, the diameter thus found must be increased about one-tenth part, the wheel being fed so much below the summit.

Breast Wheels,

Where the water is applied between the centre and the top, or vertex.

The efficiency of breast wheels varies from six to seven tenths of the total power of the water, according to the height at which they are fed; the higher the feed, the greater the proportionate efficiency. The best speed for the periphery of breast wheels is the same as for overshot wheels, but the speed may be varied, as above explained, without serious loss, when circumstances require it. The speed of the water should also have the same ratio to that of the wheel, as in the case of overshot wheels. When the level of the water is subject to much fluctuation, these wheels should not be fed higher than from 60° to 90° below the summit. Their *diameter* will thus be best made about 1⅓ times the total fall, less 1, 2¼, or 4 feet respectively, according to speed, for wheels fed at or below the centre; and about twice the total fall, less the same, for wheels fed between the centre and 60° from the summit.

Undershot Wheels.

The term undershot is applied to a wheel when the water strikes at or below the centre.

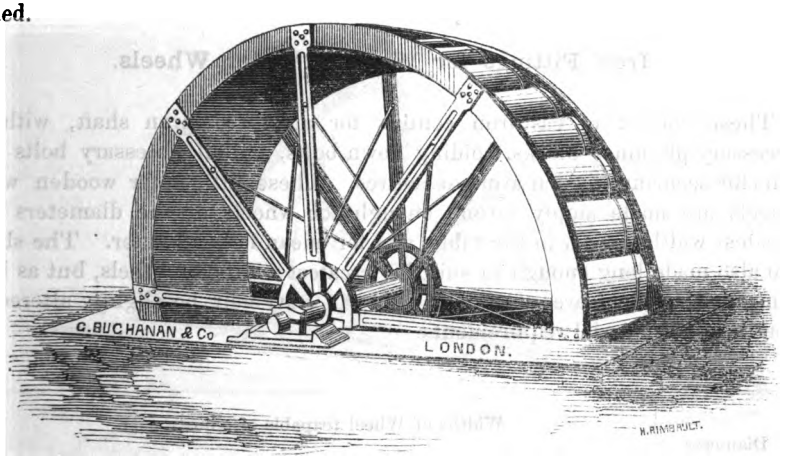
The efficiency of undershot wheels, if with straight floats, is from three to four tenths of the total power of the water; but if with curved floats, their efficiency is equal to half the power of the water. Undershot wheels are most useful for falls not exceeding 4½ feet. *The best speed* for the periphery of these wheels is 8 to 10 feet per second, the water having, as in other wheels, *double* the velocity of the wheels. The diameter of undershot wheels is regulated alone by the speed desired to be given to the shaft.

Ventilated Buckets.

In the old construction of water wheels, great unsteadiness of motion, besides much loss of power, arose from the buckets being wholly closed in, and thus preventing the escape of the air from them when being filled with water. In wooden wheels this difficulty is imperfectly met, by drilling a few holes in the sole of the buckets; but, in iron wheels, arrangements of the most perfect kind are readily adopted for relieving the buckets of air, however rapidly they may be filled. In the wheels constructed by G. B. & Co., this improved plan is uniformly adopted. The great advantage of ventilating the buckets of water wheels is not confined to the filling of them, but also is apparent in discharging them, especially when the wheels, from a rise or flooding of the tail-race, "*run in backwater*," when the admission of air to the buckets is highly necessary, in order to prevent a partial vacuum being formed, which retards the escape of the water, and thus reduces the useful effects of the wheel at a time when the power is already diminished from the temporary reduction in the fall.

Iron Water Wheels.

These wheels are constructed with ventilated buckets, as above described, wholly of wrought-iron, with the exception of the centres for arms, and the shrouding, which are of cast-iron. The shaft is, according to the circumstances for which it is intended, of cast or wrought iron, and is fitted with all necessary plummer blocks, and holding down bolts. They are made of any widths or diameters, the following being the most usual sizes. These wheels are suitable for either overshot, breast, or undershot wheels, the buckets being duly proportioned, according to the manner in which they are filled.



The prices include the wheel complete—viz., the arms, centres, shrouding, buckets, shaft and bearings, and all holding down bolts. These prices do not, however, include any rack, or other gearing.

Dia. of Wheel.	Width of Wheels.							
	3 ft.	4 ft.	5 ft.	6 ft.	7 ft.	8 ft.	9 ft.	
8	£	£	£	£	£	£	£	
10								
15								
20								
22								
25								
30								
35								
40								
50								
60								

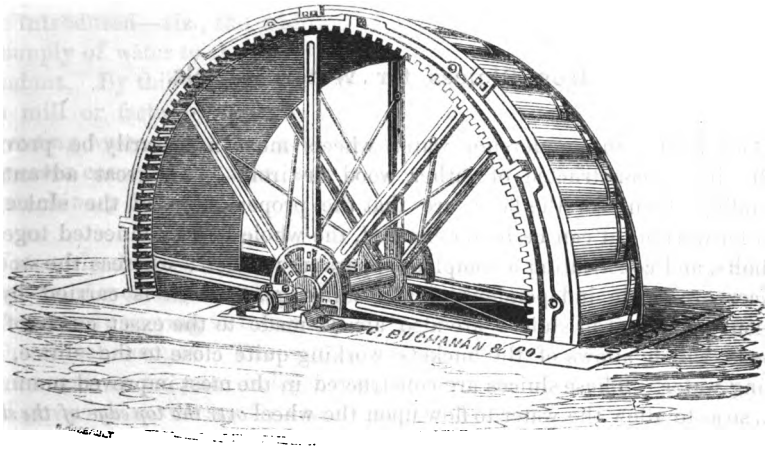
Iron Fittings for Wooden Water Wheels.

These consist of cast-iron centres for arms, cast-iron shaft, with all necessary plummer blocks, holding down bolts, and all necessary bolts and nuts for securing wooden arms to centres. These fittings for wooden water wheels are made amply strong enough for wheels of the diameters and greatest widths given in the table, and for mean falls of water. The shafts are also made long enough to suit the greatest widths of wheels, but as both arms and buckets are of timber, they can obviously be slightly altered in length to suit special requirements.

Diameter of Wheel.	Widths of Wheel (capable of adjustment).		
	From 3 to 5 feet.	From 5 to 7 feet.	From 7 to 9 feet.
15	£	£	£
20			
25			
30			
35			
40			
45			
50			
60			

If with wrought-iron shaft, about extra.

Toothed Segments for Water Wheels.



These segments are bolted on to the shrouding of water wheels. The pitch of teeth being in proportion to the powers of the wheels of the diameters and greatest widths given to the tables, and with mean falls of water.

Diameter of Wheels.	10 ft.	15 ft.	20 ft.	25 ft.	30 ft.	35 ft.	40 ft.	45 ft.	50 ft.	60 ft.
Prices. 5 ft. wide	£	£	£	£	£	£	£	£	£	£
Prices. 7 ft. wide										
Prices. 9 ft. wide										

Iron Sluices for Water Wheels.

Both breast and undershot water wheels must necessarily be provided with sluices, constructed of either wood or iron. The great advantages attending the use of the latter are that the proper fixing of the sluice and gear for working it can be better ensured, the whole being connected together by bolts, and constituting a complete apparatus in itself; whereas the wooden sluices are made independent of the sluice gear, which is carried by the masonry. The iron sluices are also always made to the exact curve of the wheels, which allows of the buckets working quite close to the sluice, thus saving water. These sluices are constructed in the most improved manner—viz., so as to allow the water to flow upon the wheel *over the top edge of the sluice*, thus making use, under all circumstances, of the whole height of the fall of water. They are calculated to deliver the water in a thin stream upon the wheel, and so as to admit of a 2¼ ft. rise of water in the penstock (viz., to the level of the head required for a velocity of 6 feet per second of the periphery of the wheel) when the wheel is stopped, besides allowing for a variation in the head of 18 inches.

The prices quoted are for iron sluices, and double-purchase gear, complete, including sluice and sluice frame, rack, pinions, weigh shaft, standard for end bearing, cast-iron case, containing double gear, with ratchet and pawl, and long winch handle.

Widths of Wheels, in feet.	3	4	5	6	7	8	9	10
Prices	£	£	£	£	£	£	£	£

Governors or Regulators for Water Wheels.

A great improvement in working water wheels has comparatively lately been introduced—viz., the addition of a governor or regulator for adjusting the supply of water to the wheel, independent of any care on the part of the attendant. By this means, the slightest variation in the demand for power in a mill or factory is met by a corresponding expenditure of water, thus preventing waste. But the governor also serves another purpose, generally of greater consequence than saving of water—viz., uniformity of speed in the machinery driven.

Water-wheel governors are necessarily rather expensive, owing to the necessity of working the sluice by the power of the water wheel itself, the governor only serving to bring this power into operation whenever the speed of the wheel changes. The size of water-wheel governors, for this reason, may be said to be quite independent of the size of the wheel, a medium-sized governor answering for almost any sized wheel.

Price of medium-sized governor, with all necessary shafts, bearings, bevel wheels, worm and worm wheels, with clutch arrangement for working by hand, complete, £ .

Alarm Governors for Water Wheels.

These governors are merely designed to give notice, by means of a bell, when any change has taken place in the speed of the wheel. They have no connection with the sluice, the position of this being altered by the attendant. In addition to the sounding of a bell, these governors are sometimes provided with an index, for showing the actual speed of the water wheel on one side, and the speed of the second motion shaft, or of the driven machinery, on the other. The sizes of alarm governors are obviously quite independent of the size of the wheels, a medium size answering for wheels of any power.

Price of medium-sized alarm governor, fitted with bell, engraved index plate, and bevel wheels for driving, complete, £ .

Rule for approximately measuring the quantity of Water available for driving a Water Wheel or Turbine, the surface speed being ascertained by a float.

As it is sometimes important to know the exact quantity of water any stream is capable of supplying for working a water wheel or turbine, the following rule will be found useful :—

The channel must be measured both in depth and width, in feet; the one dimension being multiplied by the other, will give the *area* in square feet.

Multiply this *area* by the *surface velocity* in feet per second; *four-fifths* of this product equals the *cubic feet of water* supplied *per second.*

Rule for finding approximately the effective horse-power of Water Wheels.

Multiply the *cubic feet of water expended per second* by the *effective height of fall, in feet.* The product, divided by 12, will give the horse-power of overshot wheels; if divided by 14, it will give the horse-power of breast wheels; and, if divided by 20, it will give the horse-power of undershot wheels.

TURBINES.

Within the present century, a new mode of applying the power of water to produce circular motion has been introduced, and of late years it has attracted much attention, and received many improvements.

The great value of the turbine consists in its being applicable to falls of water so high or so low that an ordinary water wheel cannot be used; and also that, in falls of great height, the velocity of the machine is so rapid, that when applied to drive fast-moving machinery, it needs no mill work, or but very little, to bring it to the required speed.

There are many places, especially in hilly districts, where high falls of water are found, and where the nature of the ground affords facilities for making reservoirs, so as to ensure a constant supply, and where the height of the column of water may compensate for the smallness of the volume. In such situations it may be conveyed in pipes to a *high-pressure* turbine, and made to work almost any class of machinery. There are other situations in which a great volume of water rolls with but little fall, and in this case even a small head of water may be rendered very serviceable. In this and similar cases the *low-pressure* turbine is used.

The prices of turbines vary considerably for different falls and quantities of water, but the following list of average sizes will enable those requiring them to form an idea of the cost of special machines not included in the list.

The following quotations are for the improved turbine, or *vortex* wheel, as it is usually called, and which possesses several advantages over those more generally in use; these advantages are—

1st. A peculiar balancing of the centrifugal force and water pressure, by which the water is admitted at a slower velocity than usual.
2nd. Great regularity of speed and steadiness of motion, the water-supply being partly regulated by the speed, and thus acting as a governor.
3rd. Uniformity of speed in the water, and the wheel itself, by the arrangement of discharging at the centre.
4th. Better means of adjusting the orifices, for variable supplies of water.

The prices include the vortices complete, of the best construction, case of cast-iron guide blades, revolving wheel of wrought iron, and turned shafting (4 feet long).

Fall.	10-Horse Power.		20-Horse Power.		30-Horse Power.		40-Horse-Power.	
	Quantity of Water, in cubic feet, per minute.	Price.	Quantity of Water, in cubic feet, per minute.	Price.	Quantity of Water, in cubic feet, per minute.	Price.	Quantity of Water, in cubic feet, per minute.	Price.
feet.								
6	1177	£	2353	£		£		£
12	588	£	1177	£	1765	£	2353	£
20	353	£	706	£	1059	£	1412	£
30	235	£	471	£	706	£	941	£

For falls of less than 8 feet, the vortex cases may be of timber; the cost in this case will be reduced. The additional cost of *moveable* guide blades and gear for working them would vary from £10 to £ according to size.

The wheels all revolve at considerable speed, but any ordinary speed for mill shafting may be obtained by a single pair of bevel wheels of convenient size.

Piping, for Turbines.

The cost of pipes will depend upon the situation; for small machines, one pipe is sufficient, but for wheels using 700 to 800 cubic feet of water per minute, the most complete and convenient arrangement is one with *four* pipes, the water being brought to the head of them in a pen trough.

WINDMILLS.

These mills are supplied by G. B. & Co. complete in every respect, with the exception of the tower, which is usually constructed of wood, and by the parties purchasing. When required, however, G. B. & Co. undertake to complete the entire mill, with iron tower.

The following prices are exclusive of the tower, but inclusive of the cap or crown, sails, fliers, horizontal shaft, together with a pair of bevel wheels, and all necessary plummer blocks and holding down bolts.

Horse-Power.*	No. of Revols. of Sweeps per minute.*	Diam. of Circle of Sweeps.	Total Height from Ground to top of Cap.	Price, delivered in London.
2½				£
4				£
7				£
10				£
15				£
20				£
25				£
30				£

* The horse-power of these mills is calculated on the assumption of a steady equable and average breeze acting upon the sails, which will give the several velocities of revolutions per minute noted in the table. The horse-power is equivalent to the ordinary nominal horse-power of steam engines.

WATER-POWER ENGINES.

The use of this class of engines has been singularly neglected in this country until very recently, although very extensively and successfully employed in Germany.

The employment of a column of water acting upon the piston of an ordinary cylinder, and so producing a reciprocating motion, is peculiarly applicable where a head of water can be obtained of, say, not less than 100 feet, and the water-supply abundant. Some of the many important purposes to which water-power engines may be applied are given below:—

For Pumping, &c.

In hilly districts, where high heads of water are obtainable, and the supply of water adequate, water-pressure engines are well suited for the working of pumps of mines; as also, by means of proper mechanism, for working winding engines, crushing or stamping mills, as well as other revolving machinery.

Estimates for machinery of this class will be furnished upon application, giving full information of the power required, with quantity and fall of water.

For Small Factories, &c.

Besides the uses above indicated there are others of equal importance, in which the employment of water-pressure engines would be attended with the greatest advantage—namely, in towns or localities where regular water-works exist (the head of water-supply not being less than 100 feet), for giving motion to small machinery, either constantly, or more especially when only occasionally at work. In many parts of London, and in other towns, water is supplied at the rate of 4d. per 1000 gallons, at a pressure of 150 feet, and

there are many trades that require occasionally to use mechanical power, but cannot employ a steam engine, for they do not want the power constantly, and they do not want much power at any time. That this power may be cheaply obtained, will appear from the following example :—It will be found, upon calculation, that the consumption of 1,500 gallons of water, at a pressure of 150 feet, will be equivalent to a horse-power (33,000 lbs. raised 1 ft. high in one minute), so that this power may be obtained, in the most convenient way possible (being available at any moment it may be required, and entailing neither attention nor expense when not in use), at a cost of about sixpence per hour, and so in like proportion for any other power. Should the charge of the water companies for 1000 gallons exceed the amount stated, of course the cost of power will be proportionately increased.

Estimates furnished of this machinery, according to specification.

Lifts for Warehouses, Factories, &c.

Lifts or hoists for raising attendants and goods in cotton factories or warehouses, as well as in lofty dwellings in towns, or country mansions, are also most ingenious and highly useful applications of water-pressure engines. In these cases cylinders and pistons are also employed, as in the cases above noticed, but the cylinders are here made equal in length to the total lift required, and of sufficient area for the pressure of water to overcome the greatest weights intended to be raised at any one time, including the friction of the apparatus.

For example, with a head of water 130 feet above the *bottom* of the cylinder (the cylinder being sunk in the ground), a piston of 11 inches diameter has been found to raise *half a ton* in *about four minutes* from the base of a house to the top floor, a height of about 45 feet; smaller weights being capable of being carried considerably higher.

Estimates furnished of these machines, according to specification.

CHAP. II.—PILE-DRIVING MACHINERY.

HAND PILE DRIVERS.

These machines are constructed in the best manner, the timbers being substantially framed together. They are fitted complete in every respect, with ladder, hammer, or tup, weighing about 16 cwt.; crab winch, wrought-iron spring jaws, chains, &c.

Price of the machine complete, as above, £

STEAM PILE DRIVERS.

These very useful and effective machines may be constructed of any size required, but the examples given below are those most generally in use. This is a very large and powerful machine, capable of driving piles, 14 inches square, at the rate of from 5 to 10 feet per minute. The hammer, weighing about 30 cwt., makes from 60 to 70 blows per minute, falling 3 feet. The total weight of the machine is about 24 tons, being easily separable for transport, the heaviest portion being the boiler (about 3½ tons). The boiler is constructed on the locomotive principle, and made capable of burning wood fuel (the chippings of the piles), so that very little if any coal is required. The entire apparatus is fixed to a substantial wood frame, which may be set on board a barge, or on the ground.

The price includes the boiler (25-horse power), with usual fittings complete, an engine to raise the piles and hammer, as well as to move the entire machine, with

suitable gearing attached. Feed pump worked by hand or by the engine, tank for water, double crab for general purposes, the whole being attached firmly to the timber frame.

Price, as above specified, complete, £ .

This machine may be worked, by three good hands, to drive piles without difficulty.

Small Size.

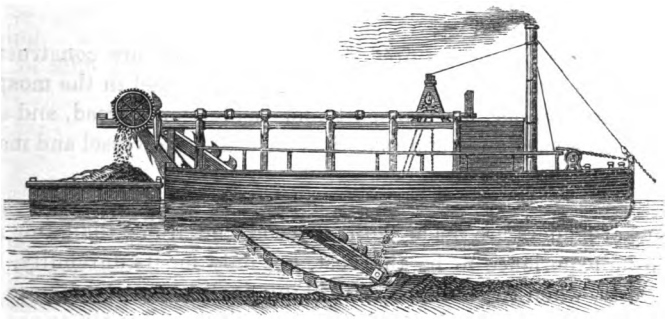
This is a very efficient machine, and better suited for light work than the one before described. The total weight of driver and boiler is only 6 tons. The hammer makes 10 strokes per minute, the fall being about 5 feet. The driver and boiler are placed on separate frames, the former being arranged to revolve so as to drive on any of the four sides. It may also be readily inclined so as to drive the piles at any angle required. The travelling wheels are castors capable of being set so as to run on rails at any angle. By a different arrangement of the upright framing, piles may be driven in a tide-way 30 feet below the stage on which the machinery stands. The height of the machine is 36 feet. When coal is burned, the consumption is about 4 cwt. in ten hours. The machine may be worked afloat or on land with equal facility.

The price includes the entire machine complete, as above described, as also a spare set of catches.

Price of machine complete, as above specified, £ .

This machine requires only four men to drive piles with it.

CHAP. III.—DREDGING MACHINERY.



Steam dredging machines have now become a necessity for the cleansing and deepening of tidal harbours, and are most invaluable in the removal of sand banks, and other accumulations in bays and bars, or approaches to harbours.

These machines are made of different sizes, powers, and draughts of water, to suit the particular purpose and locality where employed.

The following particulars of two iron steam dredging machines, constructed at York Place Iron Works, for the Egyptian Government, will give a general idea of the class of machine now in use.

No. 1.

Length	87 feet.
Beam	18 „
Depth	7 „

Fitted with condensing engines of 25-horse power, with boilers and connexions complete. Bucket ladder on each side of vessel of sufficient length to excavate to a depth of from 7 to 18 feet.

Price of one machine *complete, and delivered in the Thames*, £

Each of the above dredging machines would, under ordinary circumstances, and when in good working order, dredge and deliver about 120 tons of clay soil, or about 160 tons of gravel or sand per hour.

Crab winches, worked by shafting from main engine, for moving the dredging machine in a forward, backward, or transverse direction.

These machines, when required for foreign places, are constructed that they may be taken to pieces, and are marked and packed in the most correct and convenient manner, for transport and re-erection abroad, and supplied with all the necessary tools and materials for fitting the vessel and machinery together at their destination.

The bucket ladders are made both of wood and iron; the latter material is found from experience to be the best, not only for its durability, but also for its rigidity, when the dredger is working in heavy soil. These ladders are sometimes placed on each side of the vessel—at other times arranged to pass through a "well" in the centre of the vessel.

The following are two other sizes—viz.,

No. 2.

Steam Dredging Machine.

Length	66 feet.
Breadth	16 „
Depth	6 „

To dredge from a depth of 5 feet to 16 feet; draught of water about 4 feet. It has a condensing steam engine of 15-horse power, with boiler and all connections complete, including donkey engine; single bucket ladder, of

best design, placed in the centre of vessel; the hull being composed of plate iron, strongly framed; crab winches worked by the engine both for backward and forward motion. This machine would excavate and deliver about 90 tons of sand, gravel, or mud, per hour.

Price, delivered in the Thames, £

No. 3.

Steam Dredging Machine.

Length ... ... 90 feet.
Breadth ... ... 24 „
Depth ... ... 9 „ 6 in.

To dredge from say 10 feet to 25 feet draught of water, about 6 feet. It has a condensing steam engine of 25-horse power, with boilers, &c., complete, including donkey engine, and fitted in other respects as the foregoing. This machine will excavate and deliver about 130 tons of sand, gravel, or mud, per hour.

Price, delivered in the Thames, £

It may in some cases be found desirable to build the "hull" of dredging machines of wood at port of destination, in which case the machinery only would be required; to meet this arrangement the following table will illustrate the value of the different parts of the machinery belonging to dredging machines of the undernoted sizes :—

Hull.			Draft of water, with Machinery complete, in Feet.	Horse Power.	Will dredge to a depth of from	Estimated quantity of soil in tons delivered per hour.	Cost.			
Length in Feet.	Breadth in Feet.	Depth in Feet.					Hull, if made of iron.	Engine & boiler including Donkey Engine.	Gearing complete with crab winches.	Total.

Mud Punts,

For carrying away the Soil raised by Dredging Machines.

These punts are made both of wood and iron. In many instances wooden ones have been preferred, especially in foreign places, from the ease with which they can be repaired; but it is proved that the depreciation, rapid wear and tear, and constant renewal of these wooden punts is very expensive, and consequently wrought iron is now universally admitted to be the best material for the purpose.

Where these punts are made of wrought iron, they are fitted with hopper in centre of vessel, having trap-doors, chains, counter weights, windlass, &c., all of which are easily worked from deck, and by which means the entire contents of hopper is at once emptied into the sea.

The dimensions and capacity of these punts vary considerably according to requirements; but the average size recommended for general purposes will contain say 20 to 25 tons of soil.

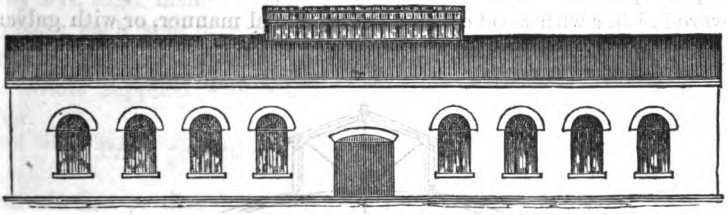
These punts are constructed with every care, and when necessary are built and taken to pieces—marked and packed with every provision to facilitate re-erection abroad, and supplied with all the necessary tools and materials.

Price of each punt *complete, as above described*, £

Other sizes made to order.

In connexion with the punts above described, it will be necessary to employ a steam tug to tow them to and from the dredging machine. The steam tug would be kept constantly running as long as the dredging machine was at work; and at other times would be found very useful in towing vessels in and out of harbour. For prices of steamer, of various sizes, *see* chap. 25.

CHAP. IV.—IRON BUILDINGS AND MATERIALS FOR FIREPROOF BUILDINGS, Viz.:



Roofs.
Iron Warehouses.
Railway Stations.
Iron Market Houses and Bazaars.
Iron Sugar Houses.
Open Sheds.
Iron Dwelling Houses.
Galvanized Iron Sheets and Tiles, Guttering, &c.
Cast Iron Girders.
Wrought Iron Girders.
Rain Water Pipes.

IRON AND FIREPROOF BUILDINGS.

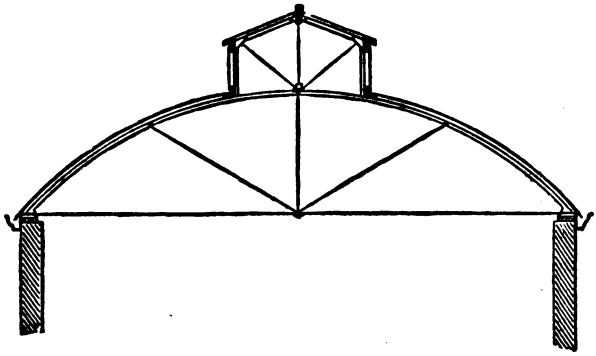
These are now coming into very extensive use, an immense number having been built within the last few years in most of the large towns of Europe and America; and ought to be adopted in all cases where permanency of construction and security from fire are required. The loss and inconvenience attending the destruction by fire in many instances of account books, documents, &c., and the suspension of business caused by the destruction of merchants' offices and manufactories is often such as no insurance could cover; but such disasters may be entirely obviated by the use of fire-proof materials, not to mention the large economy in the saving of annual insurance premiums.

Warehouses, stores, market houses, and all other buildings constructed *entirely* of iron, with sides and ends of the same material, are peculiarly adapted to resist the destructive effects of *earthquakes, gales, hurricanes, &c.*

IRON ROOFS.

The following sketch is an example of one of the best iron roofs constructed over railway and other public buildings; and for economy, lightness, and efficiency it has not been surpassed.

The principals are spaced either three or four to the bay of 20 feet, and are covered either with wood or slates in the usual manner, or with galvanized corrugated iron sheets or tiles.*



These roofs are easily adapted for the introduction of louvres or skylights.

Wrought iron roofs of the above description, formed of flat bars and plain, that is, adapted to be all stated. Principals spaced to the bay.

Prices of the iron work only, ready to be covered with wood, &c., packed for shipment:—

					Price delivered in London.
A roof 100 feet long by 30 feet span,					£
Ditto	„	„	40	„	£
Ditto	„	„	50	„	£
Ditto	„	„	60	„	£
Ditto	„	„	80	„	£
Ditto	„	„	100	„	£

Fitted with skylights, or with louvres and skylights, at a slightly increased cost.

These roofs are also admirably adapted for Sugar Houses, and are specially designed by G. B. & Co. for that purpose, with ample means of ventilation for letting out the steam arising from the sugar pans, and plenty of light.

* For prices of sheets or tiles, see page

They have a very elegant appearance, are very portable, and easily erected, and are perhaps the cheapest roof that could be adopted. This material has also the advantage of being fireproof.

The annexed illustration shows a roof supplied by G. B. & Co. for the Sugar House of the Umzinto Sugar Company, Natal, South Africa, consisting of the following, viz.:—

One galvanized corrugated iron roof for a sugar house, 130 ft. long by 34 ft. wide outside the walls, with a ventilating light in centre, 30 ft. long by 6 ft. wide, by 2 ft. high, made to open at both sides, and glazed with strong rough plate glass; each side of roof fitted with five half round galvanized wrought iron gutters and brackets and 3-in. down pipes.

The whole supplied with all the necessary rivets and screws for putting together.

Price, packed and ready for shipment, £

Roofs similar to the above are constructed by G. B. & Co. of any size required, the ventilating lights being of proportionate dimensions.

Length.	Breadth.	Price delivered in London.	Extra for delivery at from tackle of Ship.
100 feet	50 feet	£	£
80 „	40 „	£	£
60 „	30 „	£	£
40 „	20 „	£	£

Other sizes at proportionate prices.

Iron Roofs.

Approximate prices per 100 square feet of ground covered.

Roofs of the ordinary Ridge Form,

Consisting of principals and other framing, covered either with slates, tiles, galvanized iron, or other material:—

	Slate.	Galvanized Iron.
In spans not exceeding 30 feet	£	£
Ditto „ 40 „	£	£
Ditto „ 50 „	£	£
Ditto „ 65 „	£	£
Ditto „ 80 „	£	£
Ditto „ 100 „	£	£
Ditto „ 125 „	£	£
Ditto „ 150 „	£	£

Roofs of the Arched Form,

Consisting of ribs or principals, with the necessary framing and covering of galvanized corrugated iron:—

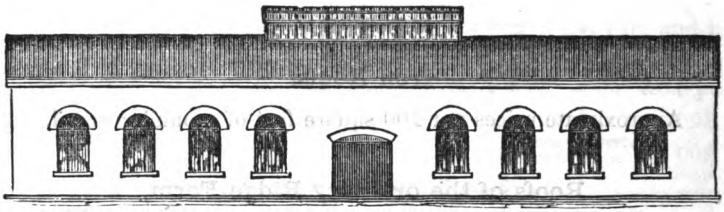
In spans not exceeding 50 feet .....£
Ditto „ 60 „ .....£
Ditto „ 70 „ .....£
Ditto „ 80 „ .....£
Ditto „ 90 „ .....£
Ditto „ 100 „ .....£
Ditto „ 125 „ .....£
Ditto „ 150 „ .....£

In the prices above quoted, the provision of skylights and ventilation, as well as gutters and rain-water pipes, has been considered.

Corrugated iron roofs in the arched form, without any framework (save tie rods and suspension rods for counteracting the thrust upon the walls), are useful for spans not exceeding 45 feet.

	Painted Iron.	Galvanised Iron.
Of No. 20 gauge iron, for spans not exceeding 25 ft.	£	£
„ 18 „ „ „ 35 „	£	£
„ 16 „ „ „ 45 „	£	£

Corrugated iron in plates and tiles, suitable for covering timber framework, ridge, capping, eaves, gutters, rain-water pipes, &c.



COMPLETE IRON WAREHOUSES,

60 ft. by 30 ft., consisting of cast iron pillars 12 ft. high, with angle iron framing, covered with galvanized corrugated iron plates at the sides and ends, with an open trellis girder carrying a simple arched roof of galvanized corrugated iron .....£
Ditto, ditto, 100 ft. by 25 ft., of similar construction .....£
Ditto, ditto, 100 ft. by 45 ft., ditto, ditto .....£
Ditto, ditto, 200 ft. by 70 ft., ditto, ditto, in two spans .....£
Ditto, ditto, 150 ft. by 40 ft., with upper storey .....£

RAILWAY STATIONS.

G. B. & Co. have already supplied several of these buildings for the colonies, designed expressly for hot climates. Their extensive experience enables them to prepare designs which provide for all the necessary and most suitable requirements in such structures. The exterior of these buildings are of different designs, and either plain or ornamental, to suit the purchaser; and the interior arranged with all the requisite offices and accommodation for passengers and traffic.

The framework of these structures is composed of cast iron columns, wrought iron trusses, girders, and iron roof, the whole covered with corrugated galvanized sheet iron. The roofs may be made *curved* or *ridged*, ample provision being made for securing good light, ventilation, and convenient means of ingress and egress.

The following prices for railway stations of various sizes will be found useful in assisting purchasers to arrive at an approximate cost of such buildings:—

Length.	Width to centre of Columns.	Height to top of Columns or Eaves.	Price delivered in London.
ft. in.	ft. in.	ft. in.	
80 0	25 0	14 0	£
120 0	35 0	16 0	£
200 0	50 0	18 0	£

The above prices include the cost of entire building, including columns, girders, roofing, skylights, ventilators, and corrugated or continuous galvanized iron sheets for covering the entire building. Internal fittings extra, according to requirements and amount of traffic; external ornamentation to suit the taste of purchasers.

IRON MARKET HOUSES.

These buildings are formed entirely of iron. The main standards or columns are of cast iron, with large pedestal bases, secured by bolts to suitable foundations.

The sides and ends of buildings, to a height of say four feet from the ground level, are panelled with corrugated galvanized sheet iron, and from this point to the eaves, or top of columns, made in a peculiar manner, similar to Venetian shutters, leaving a space between each bar, which ensures a perfect circulation of ventilation.

The columns at top are connected together by wrought iron ornamental trellis-work, which not only make the structures secure, but acts as an additional means of ventilation.

The roofs of these buildings are composed entirely of iron—wrought iron frames, stays, ties, king rods, &c., the whole covered with galvanized corrugated sheet iron.

Ventilators are placed on the roofs, and secured thereto by bolts and nuts. These ventilators are made in various designs, and some of them arranged with slides or shutters, which can be opened and shut at pleasure.

Access to the buildings is obtained by large wrought iron ornamental gates at each end, and, if necessary, at sides of structure.

Gutters with connecting pipes fitted round these buildings for carrying off the rain-water.

The interior fittings and external ornamentations vary according to requirements, but the following prices will represent the cost of buildings described:—

Length.	Breadth.	Height to Eaves.	Price.
ft. in.	ft. in.	ft. in.	
80 0	30 0	14 0	£
100 0	35 0	15 0	£
150 0	40 0	16 0	£

Designs and estimates furnished for all other sizes of buildings.

GALVANIZED CORRUGATED IRON SUGAR HOUSE.

The annexed is an illustration of an iron sugar house suitable for manufacturing four tons of sugar per day, and made of galvanized corrugated iron throughout.

As will be seen, it consists of two ranges of buildings, with circular iron roofs, supported on iron columns, the spaces between the columns or walls being also filled in with corrugated iron, iron windows, doors, and chimney, the whole forming a *compact and neat fireproof* building, with plenty of light and ventilation in the roof for the exit of the steam.

The largest range contains the cane mill and engine at one end, and the sugar cooking apparatus at the other; while the open shed is for the clarifiers, and the other parts of the smaller range is intended to receive the boiling pans, which are separated by a fireproof partition from the part containing the finished sugar.

The illustration shows the style of corrugated iron buildings G. B. & Co. are in the habit of supplying for the colonies, and which they strongly recommend for sugar houses, sugar stores, &c., as being neat, portable, fireproof, easily erected, and in many cases ultimately the cheapest to the planter.

The building above specified (for four tons of sugar per day) costs about £ , delivered in London, packed for shipment, ready to be erected abroad.

The following is a specification of a complete set of G. B. & Co.'s improved sugar machinery for making four tons of good bright grocery sugar per day, suitable for an iron sugar house of the size above specified, viz.:—

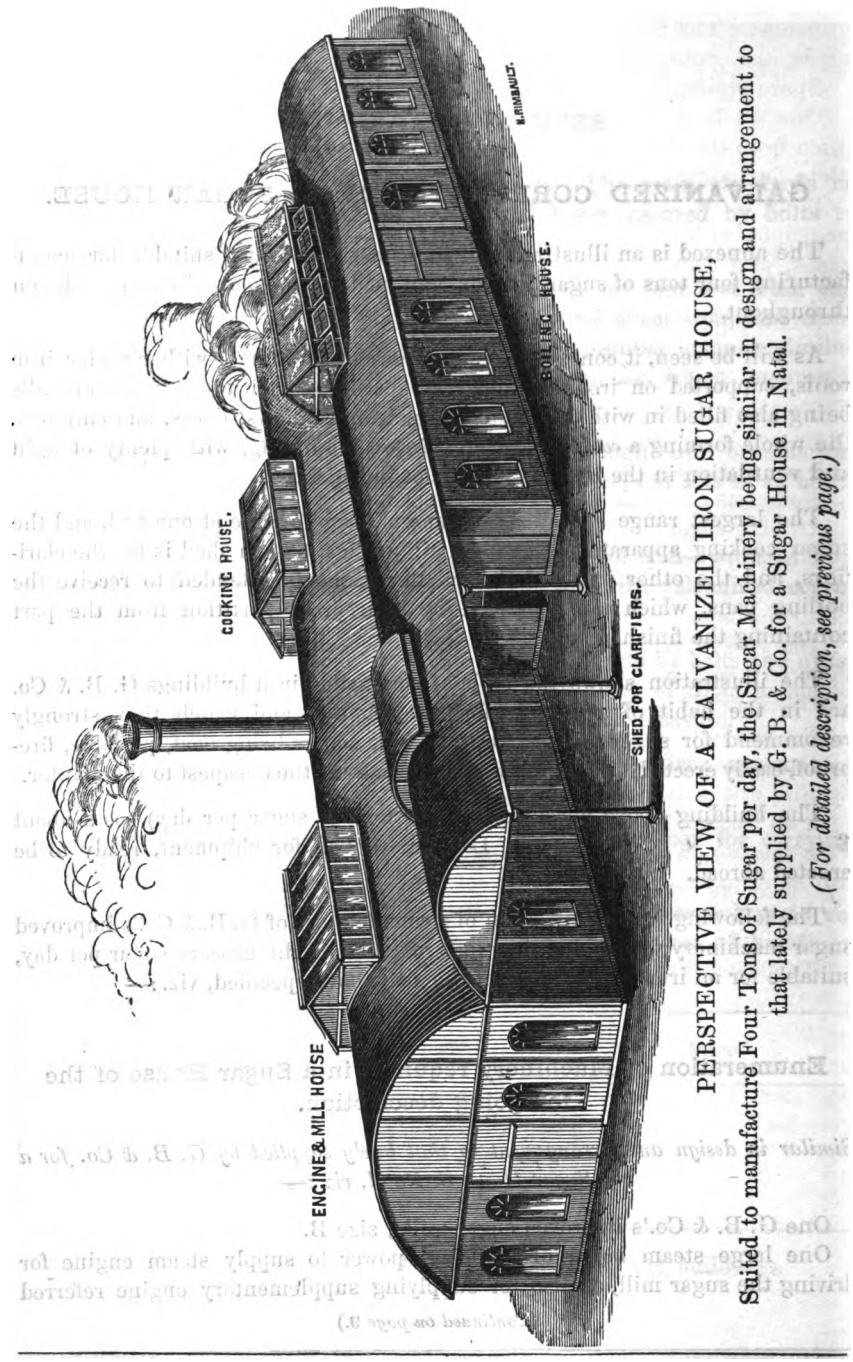
Enumeration of Machinery required in a Sugar House of the foregoing description.

Similar in design and arrangement to that lately supplied by G. B. & Co. for a Sugar House in Natal, viz.:—

One G. B. & Co.'s improved sugar mills, size B.

One large steam boiler of sufficient power to supply steam engine for driving the sugar mill, as also for supplying supplementary engine referred

(*Continued on page* 9.)



PERSPECTIVE VIEW OF A GALVANIZED IRON SUGAR HOUSE,

Suited to manufacture Four Tons of Sugar per day, the Sugar Machinery being similar in design and arrangement to that lately supplied by G. B. & Co. for a Sugar House in Natal.

(For detailed description, see previous page.)

GALVANIZED CORRUGATED IRON SUGAR HOUSE.

to below. The boiler is suited to burn wood or megass fuel, with all fittings, pipes, and connections.

Spare piping, &c., for ditto.

One G. B. & Co.'s improved continuous action montejus for raising the juice from the mill to the clarifiers, with juice delivery pipes, &c., &c., complete, including connecting steam pipe.

Four G. B. & Co.'s improved 500 gallon clarifiers, on the waste steam principle, with internal copper heaters, double bottoms, cocks, stop valves, pipes, and connections to boiler and cane mill engine, loaded escape valve, &c., &c.

Spare piping, &c., for ditto.

Two batteries of pans, with shoulders cast in one piece, and bolted together, with grate and furnace fittings, &c., &c., complete.

Two wetzel pans complete.

Spare piping, &c., for ditto.

Four centrifugal sugar-curing machines, fitted with steam jet.

Four sets of counter gearing for driving the same.

Driving straps and piping for ditto.

One high-pressure engine of six horse power for driving centrifugals and wetzel, with all pipes and connections to boiler of cane mill engine and to centrifugals and wetzels.

One cast of rust cement, in addition to what is supplied with the steam cane mill engine.

One scumming press.

Six jars of temper lime.

One dozen ladles, and six skimmers.

Fire bricks and clay for boiler setting.

Two Beaumé's saccharometers.

Duplicate pieces and spare pipes, the latter supplied in case any alteration in the arrangement of the machinery might be thought desirable.

A set of spare articles for cane mill and engine, &c.

Packing cases.

Tools and machinery for erecting the machinery.

SUGAR HOUSES.

Another class of sugar house which G. B. & Co. highly recommend, and which they have already supplied, is as follows:—

The framework of house may be constructed of wood, the pillars being formed of any rough hewn timber poles, spaced say eight or nine feet apart, and sunk into the ground say three or four feet. When these poles have been cut to an uniform height, the whole to be tied together by a wooden wall plate, and braced where necessary by wooden stays. The spaces between the poles form openings where required. Horizontal pieces of wood to be then fastened to the poles, on which the sheeting will be nailed.

This completes the framework of house, and it only remains to cover it in, both sides, ends, and roof, which is quickly and most economically done by the continuous galvanized iron sheeting (see page —). This covering is found admirable adapted for the purpose, and the ease with which it can be applied, even by the most inexperienced persons, renders it a very valuable covering for buildings in the colonies.

Such buildings can be erected in a very short time compared with those of different materials, which is often a great consideration; added to which, the materials required for these houses—wood and galvanized sheeeting—are so easily obtained, the former in the neighbourhood of erection, and the latter supplied by G. B. & Co., complete, with all nails, screws, and tools, ready for fixing.

The total cost of this covering for any size building can be easily ascertained, by measuring the entire surface, including sides, ends, and roof, in feet, and dividing the total by 100; the result will be the number of *squares*, and the price per square will be found on referring to page —.

A most important feature in this galvanized sheeting is, that it can be applied with equal facility to any roof of whatever shape.

IRON BUILDINGS FOR BAZAARS.

G. B. & Co. have lately constructed an iron bazaar for the town of Mahæbourg, Mauritius. It consists of a segmental or curved roof, strongly framed with principals, about 8 feet apart, supported by cast iron columns and wrought-girders. The roof is covered with galvanized corrugated iron, and is closed in at one side and two ends. The columns are strongly bolted down to masonry, to afford security against strong gales or hurricanes. The dimensions of the building are—

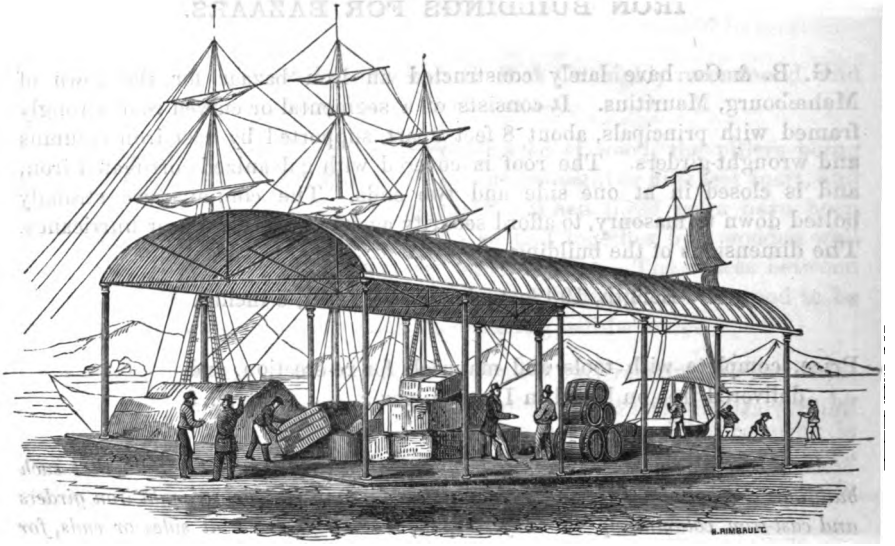
Length, 190 feet; breadth, 24 feet, 6 inches.

Price, complete with tools and materials for re-erection, and delivered free on board in London, per.....£

As a general rule for guidance in forming prices, it may be stated that such buildings can be supplied with segmental roofs *supported on wrought-iron girders and cast-iron columns up to* 45 *feet span, but not enclosed at sides or ends, for ordinary height of column, for about* £ *per* 100 *square feet, covered. If with* ridge, *or flat surfaced roofs, at* £ *per* 100 *square feet covered.*

All of the best quality of materials and workmanship, and fitted and marked, so as to be put together again with facility on the spot.

GALVANIZED CORRUGATED IRON OPEN SHEDS.



Suitable for *Dock sheds, Megass sheds, Stores, &c.* The roof is made entirely of galvanized corrugated sheet iron, carried on wrought iron frames, ties, king rods, &c., and supported by cast iron columns and girders.

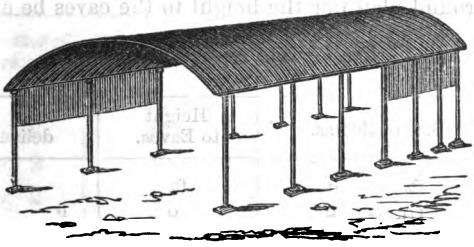
Sometimes wooden columns are used instead of iron, which former material would be supplied on the place of erection.

Length.	Breadth.	Height to Eaves or top of Columns.	Price with Iron Columns.	Price of Roof complete, without Columns.
ft. in.	ft. in.	ft. in.		
80 0	25 0	14 0	£	£
100 0	25 0	14 0	£	£
150 0	30 0	15 0	£	£
200 0	35 0	16 0	£	£
300 0	46 0	16 0	£	£

The above are erected and fitted together here, and carefully marked for re-erection.

Prices are here given of sheds actually built, selected as useful examples from which to compute the approximate cost of others:—

A coal shed, 300 ft. by 46 ft., consisting of cast iron pillars, 20 ft. apart, with arched girder carrying a simple corrugated roof.....£



A megass shed, for storing the cane trash on a sugar estate, 100 ft. by 48 ft., roof on iron framework, covered with galvanized corrugated iron, on pillars 12 ft. high .....£

Railway carriage sheds, 100 ft. by 21 ft. .....£

Dock shed, 300 ft. by 50 ft., massive iron stanchions, 14 ft. high and 20 ft. apart, with arched girders carrying roof of wrought iron ribs and framework, covered with galvanized corrugated iron .....£

IRON DWELLING HOUSES.

These are made in various designs and sizes, according to requirements.

The framework of these buildings is constructed with timber or iron framing. They are exceedingly light and strong, and can be erected with great facilty and speed.

The inside of the building is also lined with wood or galvanized sheet iron, which effectually resists the radiation of heat from the sun, and keeps the rooms cool and pleasant.

The *interior* of these buildings are arranged to suit the accommodation required, and the *exterior* ornamentation, with projecting porches and verandahs, to suit the taste of purchasers.

These buildings are fitted up together at the Works, the various parts marked and carefully packed, and plain directions and necessary drawings furnished for their erection abroad.

The prices of iron buildings depend materially on the accommodation and decoration required; those that are annexed are for houses with rooms of the sizes indicated, or such other sizes as may be required, provided neither the area of the ground plan nor the height to the eaves be exceeded.

Porches and verandahs extra.

Number of Rooms.	Size of Rooms.	Height to Eaves.	Price delivered in London.
	ft. ft.	ft.	
2	10 × 8	8	£
4	10 × 10	10	£
6	13 × 12	10	£
8	14 × 14	12	£

Estimates and designs furnished for all other sizes, designs, and descriptions of *houses, churches, military hospitals, barracks.*

Galvanized Corrugated Iron Sheets.

These sheets are supplied of various sizes of surface, thickness, and corrugations, as required, and either flat or curved to any desired radius; and, if necessary, bolts and nuts for fixing the sheets are sent with them for erection.

Gauge.	Average size of Sheets.	Number of Sheets to the Ton.	Weight of Sheets per square of 100 feet, *fixed.*	Price per Ton.
	ft. ft.		lbs.	
16	6 × 2	56	352	£
18	6 × 2	70	290	£
20	6 × 2	90	220	£
22	6 × 2	107	185	£
24	6 × 2	128	154	£
26	6 × 2	150	132	£

Galvanized Sheet Iron Tiles.

The tiles are suitable for the ordinary hip roof, and so arranged that they may be fitted to any existing roof of the kind. These tiles are secured to wooden battens or laths by nails and screws, and require no skilled labour for erection.

Gauge.	Average size of Tiles.	Number of Tiles to the Ton.	Weight of Tiles per square of 100 feet, *fixed.*	Price per Ton.
	ft. ft.	*about*	lbs.	
24	3 × 2	335	141	£
26	3 × 2	400	118	£
28	3 × 2	460	103	£

Galvanized Iron Continuous Roofing Sheets.

These sheets are made to any length, varying from 50 feet to 500 feet, with a constant width of 2 feet. The usual thickness is 28 and 31 gauge, but the former is preferred as most suitable for general roofing purposes.

The great advantage attending the use of this particular kind of roofing material is, that it may be laid the whole length of the building in one uninterrupted piece without any joint. The cost is also considerably less than any other material, and it can be laid on without difficulty by the most inexperienced person.

Sufficient galvanized nails are sent along with sheets, also erecting tools.

Gauge.	Weight per square of 100 feet, *fixed.*	Price per square of 100 feet.
31	56 lbs.	£
28	84 „	£

Galvanized guttering of different designs, elbows, ridge caps, nails, bolts, nuts, rivets, burrs, &c., as may be required.

The mode of fixing this galvanized continuous sheeting is very simple. The sheets are cut to the required length, and the first line of sheeting nailed on next the bottom *or* eaves *of roof; the next sheet is then placed so that its lower edge overlaps the bottom sheet, say about one inch, through the middle of which lap the galvanized nails are driven, about one inch apart, through both sheets. A thick layer of* paint, *or a narrow strip of* felt *or* bunting, *may be placed between the lap, which will secure a perfect and permanent water-tight joint.*

Cast Iron Girders,

Suitable for buildings, roadways, &c., made to any required length and section.

Wrought Iron Girders,

Of any required size and section, according to order.

Rain-Water Pipes and Connections,

Of various designs and sizes, according to requirements.

Description.	2 in.	2½ in.	3 in.	3½ in.	4 in.	5 in.	Price.	Price if Galvanized
Plain Pipes.....per yard								
Heads, flat and angle ...each								
Shoes..... „								
Branch Pipes, single ... „								
Ditto, double ... „								
Boots, Elbows, Plinth Bends, and Swan Necks .....each								
Off Sets, or Small Necks, projecting 6 inches .....each								
Ditto, 8 „ ..... „								
Ditto, 10 „ ..... „								
Obtuse Elbows ..... „								
Loose Sockets ..... „								
Ornamental ditto ..... „								

CHAP. V.—ENGINEERS' TOOLS AND FOUNDRY FITTINGS, &c.

G. B. & Co. contract for the supply of all kinds of tools and fittings used in machine factories and foundries.

A large number of the machines are constructed at G. B. & Co.'s own works, and the rest are supplied to them by makers of known repute, who, by confining their manufacture to certain special kinds, are enabled to supply them at the lowest possible cost.

The advantages of ordering a complete plant through G. B. & Co., consist in their experience and knowledge of the trade enabling them to make the best selection, and to lay out the plant in one harmonious design; while, as to prices, *they can supply any of the machines which they do not themselves manufacture upon the same terms as those upon which they would be obtained direct from the manufacturers.*

By a careful and judicious selection and arrangement, it is often found possible to reduce the number of machines required for a series of operations, which economic result would not be so advantageously obtained when the plant is ordered in detail.

For full particulars of Colonial Repairing Shops, with motive power and shafting, &c., complete, see pages 17, 18, *and* 19, *of this chapter.*

The great variety of machine tools now manufactured, renders it difficult to give *complete* lists of prices, but the following will be found a valuable summary of the most useful tools required in the manufacture and repair of machinery.* The prices are for tools of the **very best materials and workmanship,** and include top-driving apparatus, screw keys, &c., complete.

* *For prices and particulars of Steam Hammers, see chapter VI.*

Foot Lathes.

Nos.	Head-stocks.	Length of Bed.	Fittings.	Price.
	in.	ft.		
1	5	4	3-speed band-wheel, steady and slide-rests, face plate, and bell chuck .	£
2	6	5	Steady and slide-rests, face plate, and bell chuck	£
3	6	5	Geared head, and self-acting sliding and screw-cutting apparatus, face plate, and bell chuck	£

Hand Lathes.

Each fitted with socket-rest holder, face plates, overhead motion, and screw keys.

GEARED HAND LATHES.

Nos.	1	2	3	4	5	6	7	8	9	10	11
Height of Centres from Bed	18	16	15	13	12	11	10	9	8½	7	—
Price	£	£	£	£	£	£	£	£	£	£	£

UNGEARED HAND LATHES.

Height of Centres from Bed	—	—	—	—	—	—	10	9	8½	7	6
Price							£	£	£	£	£

COMPOUND SLIDE-RESTS FOR HAND LATHES.

Height of Centres from Bed	18	16	15	13	12	11	10	9	8½	7	6
Price	£	£	£	£	£	£	£	£	£	£	£

Ordinary Self-acting Slide and Screw-Cutting Lathes.

No.	Height of Centres from the Bed.	Length of Bed.	Price.	Extra price for Leading Screw and Change Wheels for Cutting Screws.	Price per foot for extra lengths of Bed Racks and Traverse Shaft.	Extra price for Lathes made with Break or Gap to allow of turning or boring drums and similar articles of large diameter. Each Lathe to be provided with planed Foundation Plates, and Screw for accurately moving the bed, or widen or narrow the gap.
	Inches.	Feet.				
1	30	25	£	£	£	£
2	24	20	£	£	£	£
3	20	20	£	£	£	£
4	18	20	£	£	£	£
5	16	16	£	£	£	£
6	15	16	£	£	£	£
7	13	16	£	£	£	£
8	12	16	£	£	£	£
9	11	16	£	£	£	£
10	10	14	£	£	£	£
11	9	14	£	£	£	£
12	8½	10	£	£	£	£
13	7	8	£	£	£	£
14	6	7	£	£	£	£
15	5½	5½	£	This Lathe is fitted with hand rack traverse motion, and also with leading screw and change wheels for cutting screws.		

Each of the above lathes, except the 5½-inch, is fitted with self-acting rack traverse motion, self-acting surface motion, slide-rest, face plates, travelling stay, overhead motion and screw keys.

Chucks for Lathes.

Nos.	Size of Lathe.	Price of 4-screwed Chucks.	Price of 3-screwed Chucks.
	inches.		
1	30	£	£
2	24	£	£
3	20	£	£
4	18	£	£
5	16	£	£
6	15	£	£
7	13	£	£
8	12	£	£
9	11	£	£
10	10	£	£
11	9	£	£
12	8½	£	£
13	7	£	£
14	6	£	£

Powerful Treble-Geared Slide Lathes,

For turning or boring fly wheels, water-wheel centres, railway turntables, and similar articles of large diameter.

No. 1. A strong and powerful self-acting slide lathe, with detached treble-geared headstock on foundation plate. Face plate, ten feet diameter, having internal and external wheel at the back of it, to be worked single, treble, or double purchase. A gap or break between the bed and fast headstock, for admitting articles of large diameter on the face plate. Bed twenty feet long, moveable on foundation plate, for widening or narrowing the gap. Moveable headstock, three feet nine inches centre. Compound slide rest, fitted on saddle. Self-acting rack traverse motion, self-acting surfacing motion, overhead motion, and screw keys ..... £

No. 2. A strong self-acting slide lathe, with detached treble-geared headstock. Face plate, eight feet diameter. Bed, twenty feet long. Moveable headstock, two feet eight inches centre, &c., and fitted same as the large lathe above described ..... £

No. 3. A strong self-acting slide lathe, with detached treble-geared headstock. Face plate, seven feet diameter. Bed, fifteen feet long. Moveable headstock, two feet four inches, centre, &c., and fitted same as the large lathe above described ..... £

Slide Rests, for the above.

Compound slide rest for No. 1 lathe, for turning large diameters on face plate, the longitudinal slide having a traverse of 6 feet, and the transverse slide a traverse of 2 feet 6 inches, with self-acting motions ..... £

Compound slide rest, with longitudinal slide, having a traverse of 5 feet, and the transverse slide a traverse of 1 foot 8 inches, with self-acting motions ..... £

Planing Machines.

These machines are self-acting, on the *horizontal, vertical and angular* cuts.

Nos.	Plane in Length.		Plane in Width.		Take in Depth.		Price.
	ft.	in.	ft.	in.	ft.	in.	
1	1	0	1	3	0	9	£
2	2	0	1	3	1	0	£
3	4	6	2	3	2	0	£
4	6	6	2	6	2	6	£
5	10	0	2	6	2	6	£
6	12	6	4	6	4	0	£
7	15	6	5	0	4	6	£
8	20	0	9	0	9	0	£

Other lengths and widths at proportionate prices.

Shaping Machines.

Strong and powerful crank planing or shaping machines, fitted with overhead motion and screw keys, complete.

Nos.	Travrs.		Stroke.		Self-Acting Motions, for Straight, Circular, Curved, Vertical, and Angular Work.	Price.
	ft.	in.	ft.	in.		
1	1	4	0	7	S. & C. only	£
2	2	6	1	8	S. & V. only	£
3	2	0	0	10	All kinds	£
4	5	0	0	10	All kinds	£
5	6	0	1	3	All kinds	£
6	6	0	1	8	S. C. & V.	£

Nos. 4 and 5 are each fitted with two tables. All the sizes are fitted with a pair of strong slide vices, for gripping the work.

Drilling Machines.

These machines are constructed as *radial, wall,* or *vertical* drills, are all self-acting, and fitted with overhead motion, drills, and screw keys.

Kind of Machines.	Nos.	Whether with Gearing for Slow Motion.	Radial Arm can be raised or lowered.	Spindle can be moved from to radius.	To drill Holes in. diameter and in. deep.	Motion of Arc, in degrees	Price.
			in.	ft.in. ft.in.	in. in.		
Radial.	1	With	18	2 8 to 6 0	6 & 11	180	£
	2	do.	21	3 2 to 7 0	8 & 14	180	£
	3	do.	24	3 6 to 7 9	12 & 16	200	£
Wall.	1	Without	—	Spindle 3ft. from Wall	2 & 11	—	£
	2	With	—	do.	5 & 11	—	£
	3	Without	—	2 8 to 5 4	1½ & 14	200	£

Kind of Machines.	Nos.	Whether with Gearing for Slow Motion.	To drill up to in. diameter and in. deep.	Admit articles in diameter.	Price.
			in. in.	ft. in.	
Vertical.	1	Without	¾ & 4½	1 0	£
	2	do.	1 & 9	2 0	£
	3	do.	1½ & 10	2 0	£
	4	Wtih	5 & 12	2 6	£
	5	do.	9 & 15	3 4	£
	6	do.	12 & 20	5 0	£

Of the vertical drilling machines, Nos. 4, 5, *and* 6 *have a cross slide and revolving table, moveable on vertical slide. No.* 3, *round rack pillar and table, to swing out of the way. And Nos.* 1 *and* 2, *table, moveable on vertical slide.*

Boring Machines.

These machines are fitted with overhead motion and screw keys, complete. Nos. 1 and 2 may be used as surfacing lathes, the chuck and tool-holder being added.

	No.	Admits Articles in depth.	To bore to inches diameter.	Traverse of Boring Bar.	Price.	Extra for 3-screw chuck and common tool-holder.	Total.
		ft. in.	in.	ft. in.			
All Horizontal.	1	2 6	9	3 8	£	£	£
	2	1 3	6	2 10	£	£	£
	3	1 6	4	1 0	£		
	4	Centre of Boring Bar from Foundation Plate, 20 inches.	To bore pair of locomotive cylinders at once.	3 6	£		
		Single Machine, same as No. 4, but to bore one cylinder only					£
	6	Portable ditto, to bore pair of locomotive cylinders in place					£
	7	To bore locomotive cylinders, and do other heavy work. Will take in article 5 ft. 10 in. diameter. Spindle, 4 ft. traverse. (Vertical Machine.)					£
	8	To bore cylinders 90 in. diameter, and 11 ft. through. Will turn on face plate 8 ft. 8 in. diameter. With rest for boring and turning wheels. (Horizontal Machine.)					£

Slotting Machines.

These machines are fitted with self-acting slides, worm table, driving apparatus, and screw keys, and are adapted for shaping a great variety of work.

Nos.	1	2	3	4	5	6	7	8	9
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
To admit articles in diameter.	2 0	2 6	2 6	3 0	3 6	4 6	5 0	6 0	7 0
Length of Stroke.	0 6	0 6	0 9	0 10	1 0	1 2	1 2	1 8	1 8
Price.	£	£	£	£	£	£			

Bolt Screwing Machines.

These machines are fitted with taps and dies rising $\frac{1}{8}$-inch, and with top-driving apparatus. They are specially adapted for screwing bolts and tapping nuts.

No.	1	2	3	4	5	6
	in. in.	in. in.	in. in.	in. in.	in. in.	in. in.
For Bolts from	$\frac{1}{4}$ to $\frac{3}{4}$	$\frac{3}{8}$ to $1\frac{1}{4}$	$\frac{1}{2}$ to $1\frac{1}{2}$	1 to 2	$1\frac{1}{2}$ to $2\frac{1}{2}$	$\frac{1}{4}$ to $\frac{3}{4}$ Double Machine, arranged so that the Machine need not be stopped to fix and loosen nuts. With double set of taps and dies.
Price	£	£	£	£	£	£

Nut Shaping Machine.

This machine is self-acting, and capable of shaping nuts, shaft ends, &c., to 6 inches diameter, with revolving cutter operating on two sides of the nut at once. With driving pulleys and screw keys.

Price, complete as above, £

Wheel Cutting and Dividing Engines.

These machines are fitted with 1 circular cutter for iron, 1 fly cutter for wood, 1 arbor, change wheels and gearing, and top-driving apparatus. Nos. 2, 3, and 4, have extra movements for bevel wheels.

Nos.	To cut Wheel in diameter.	Depth of Wheel on face.	Price.
	ft. in.	ft. in.	
1	1 6	0 3	£
2	3 0	0 6	£
3	6 0	1 0	£
4	12 0	1 2	£

Price of wheel cutter making machines, £

Hand Screwing Tackle.

Nos.	Pairs of Stocks.	Tap Wrenches.	Pairs of Dies.	No. of Taps.			Sizes.	Price.
				Taper.	Plug.	Master.		
1	1	1	3	3	3	3	$\frac{3}{16}$ $\frac{1}{8}$ $\frac{5}{16}$	£
2	1	2	3	3	3	3	$\frac{5}{8}$ $\frac{1}{2}$ $\frac{5}{8}$	£
3	1	2	3	3	3	3	$\frac{3}{4}$ $\frac{7}{8}$ 1	£
4	1	2	4	4	4	4	$1\frac{1}{8}$ $1\frac{1}{4}$ $1\frac{3}{8}$ $1\frac{1}{2}$	£
5	1	2	4	4	4	4	$1\frac{5}{8}$ $1\frac{3}{4}$ $1\frac{7}{8}$ 2	£
6	1	2	4	4	4	4	$2\frac{1}{8}$ $2\frac{1}{4}$ $2\frac{3}{8}$ $2\frac{1}{2}$	£

Punching and Shearing Machines.

The three first of these machines are made to punch one side and shear on the other. The three last punch below and shear above.

Nos.	Will punch holes in diameter.	Through plate in thickness.	At distance from edge.	Price.
	inches.	inches.	inches.	
1	$1\frac{1}{4}$	$1\frac{1}{4}$	24	£
2	1	1	22	£
3	1	1	14	£
4	$\frac{3}{4}$	$\frac{3}{4}$	12	£
5	$\frac{5}{8}$	$\frac{5}{8}$	12	£
6	$\frac{1}{2}$	$\frac{1}{2}$	8	£

Plate Bending Machine.

Nos.	1	2	3	4
Will bend plates in width	10 feet	8 feet	6 feet	$4\frac{1}{2}$ feet
Price	£	£	£	£

Plate Planing Machine.

This machine is adapted for planing the edges of iron plates, for iron ship building. It has a stroke of 30 inches, and is very powerful.

Price, complete, £ .

Hydraulic Presses.

These machines are specially designed for use in engineers' shops, &c. Each machine is fitted with pumps complete.

Nos.	Diam. of Rams.	Specially constructed for	Price.
	inches.		
1	8	Putting Railway Wheels on and off their axles. 12 in. stroke. Portable, mounted on wheels	£
2	8	For testing Carriage Springs. Lever graduated for tons	£
3	6	For testing strength of Beams and Girders. Lever graduated for tons...	£

Bar Sawing Machine.

Adapted for sawing both ends of bars of iron, fitted with two circular saws 3 ft. 6 in. diameter, two strong heads, adjustable on planed plate, to cut bars varying from 7 to 24 ft. long.

Price, complete as above, £ .

Foundry Ladles.

With improved apparatus for pouring and skinning metal with accuracy.

No. 1. To contain 2 tons, price £
„ 2. „ 4 „ „ £
„ 3. „ 6 „ „ £

Smaller sizes supplied.

Cupolas.

Wrought-iron Cupola, to contain 1½ tons of metal, with fan, &c., complete ..... £
Ditto, to contain 3 tons ..... £
Ditto, „ 5 „ ..... £

Other sizes in proportion.

Foundry Cranes.

Fitted with suitable traversing gear, to lift 3 tons ..... £
Ditto, ditto, 6 „ ..... £
Ditto, ditto, 10 „ ..... £

Other sizes in proportion.

Vices.

The vices have all parallel grips. They are of the three following kinds:—

Size of Jaws.	Bench Vice.	Portable Vice.	White's Portable Vice, with Table.
inches.			
4	£		
4½	.....	£	
5	£	£	
5½	.....	.....	£
6	£	£	£
7	£	£	£

Screw Jacks.

These jacks are of four kinds. They are respectively of the best construction.

Description.	Haley's Patent.	Tripod Jacks.		Bottle Jacks.	
		Ordinary.	With Improved Double Pawl Lever.	Ordinary.	With Improved Double Pawl Lever.
For 2 tons.	£	£	...	£	
4	£	£	£	£	£
6	£	£	£	£	£
8	£	£	£	£	£
10	£	£	£	£	£
12	£	£	£	...	

Patent Travelling Jacks.

With Double-pawl Levers.

Price of carriage size, complete, £

Price of engine size, complete, £

Ratchet and Crank Braces and Spanners of every kind.

SPECIAL MACHINES FOR LOCOMOTIVE WORK.

Wheel Turning Lathes.

These machines are treble geared, have two driving heads, capable of turning a pair of wheels for locomotive engines when keyed on their axles, or separately on each face plate. Two strong saddles, moved on the bed by rack and pinion. Two compound slide-rests, moved in the saddles to and from the centre by screws, strong beds, driving apparatus, and screw keys.

Nos.	1	2	3	4
For wheels in diam. .	7 ft.	6 ft.	5½ ft.	4 ft.
Price	£	£	£	£

Crank Axle Lathe.

Strong double-geared lathe, with bed long enough to admit articles 10 ft. 6 in. between the centres; self-acting rack traverse motion; fast headstock, on foundation plate; face plate 6 ft. diameter, for conveniently fixing balance weights; moveable headstock, 28 in. centre; two strong self-acting saddles, with self-acting surfacing motions, for turning crank axles with two tools at once; overhead motion and screw keys. This lathe will also turn two wheels at once up to 4 ft. diameter, when keyed on axle.

Price, complete as above, £

Slotting Machine, for Locomotive Frame Plates.

Strong machine for slotting and shaping the frame or turn plates of locomotive engines, 8-in. stroke, bed 24 ft. long, to admit articles 4 ft. wide; two cross slides, with self-acting longitudinal rack motion, and self-acting transverse motion; self-acting overhead motion, for adjusting the strap to the motion of the slides and screw keys.

Price, complete as above, £

Axle Grooving Machine.

For grooving both ends of railway axles, &c., at once, with bed 12 ft. long; to admit axles upwards of 7 ft. long; with self-acting screw traverse motion, stays, driving apparatus, and screw keys.

Price, complete as above, £

Price of smaller machine, for carriage and truck axles, £

Price of very large machine, capable of cutting 3 axles at one time at both ends, £

Horizontal Slotting Machine.

Adapted for cutting key beds in railway carriage wheels, 9-in. stroke, with table 4 ft. 6 in. diameter.

Price, complete as above, £

COLONIAL REPAIRING SHOPS,

With motive power and shafting, &c., complete.

The following are the particulars of a very useful plant, suited to repair stationary and marine engines, and general machinery:—

MACHINES IN TOOL SHOP.

Cost delivered in London.

One 4-horse power high-pressure engine and shafting..... £
One 15-inch strong self-acting slide lathe, for turning sugar mill rollers, and other heavy work, with a sliding bed arranged to form a gap next the headstock to allow of drums, and other articles of large diameter, being bored out. Also, with screw cutting apparatus for cutting screws of sugar mill, holding down bolts, and large marine-engine bolts, &c. ..... £
One 7-inch self-acting screw cutting lathe, without screw cutting apparatus ..... £
One vertical drilling machine, to drill up to 1 inch diameter £
Three vices and small tools ..... £

FOUNDRY.

Wrought-iron cupola, to melt 1½ tons of metal at one time, with fan, &c., complete..... £
An assortment of ladles, boxes, and moulder's tools, &c.... £
Foundry crane, to lift 3 tons ..... £
Iron work for foundry stove ..... £
Brass furnace fittings, including six 32-lb. pots and tongs, &c..... £

SMITH'S SHOP.

One forge and bellows, complete; anvil and smith's tools . £

BOILER SHOP.

One portable forge. An assortment of rivetting tools.. ... £

Belting and contingencies ..... £

Total cost, delivered in London ..... £

Should heavier castings be required, a pit, or, as it is technically termed, a "sow," can be dug in the foundry floor, and one fitting of the cupola poured into it, which will keep hot until the next fitting is melted, and the two can then be mixed together, and a casting of three tons made from them.

The plant above noted is similar to one lately supplied by G. B. & Co. for Natal, South Africa, with such additions as experience has shown to be desirable.

A *galvanized iron roof* was also furnished for the building, 110 feet long by 25 feet wide, provided with ample light and ventilation, the cost of which, delivered in London, is £

Estimates for iron roofs, iron sliding doors, guttering, columns to support shafting, and all other iron work required for the buildings, forwarded on receipt of specification of requirements.

Small Colonial Repairing Shop and Saw Mill.

The following is the cost of a plant of this description, for which G. B. & Co. have had inquiries, and believe would be found generally useful:—

One portable steam engine, of 5-horse power, with shafting and drums, &c., complete ..... £

One 10-inch lathe, for cutting screws..... £

One 7-inch ungeared hand lathe, for turning wood ..... £

One punching machine, to punch holes ¾-inch diameter, through ¾-inch plate..... £

One vertical saw frame, driven by a belt, size No. 7, to cut up 20-inch logs ..... £

Saws and buckles for ditto, as per specification, according to the kind of timber to be cut. Average cost, about ... £

One circular saw and table, with saw 24-inches diameter .. £

Driving belts, &c..... £

Total cost, delivered in London ..... £

Large plants furnished to specification.

CHAP. VI.—STEAM HAMMERS.

These admirable machines are now constructed to meet every possible requirement, from the light work of the smith to the heaviest class of forgings, as also for puddling forges. They are constructed either with *fixed* or *moveable* cylinders, the force of the blows being increased either by the re-action of the air compressed above the piston, or by the direct action of the steam. The anvils, hammers, and squeezer faces for these machines are either of the ordinary kind, or on an improved principle, suited for the circulation of water through them, by which their durability is much increased.

Hammers for Smith's Work.

These small hammers are extensively used in the smiths' shops of engineers, ship-builders, railway companies, &c., and their employment in connection with dies for the ready multiplication of a number of similar articles is becoming very general. For heavier kinds of smith's work, these small hammers are also far more economical, both in time and fuel, than where hand labour is employed, work being finished in *one* instead of *several* heats, the quality of the work being from this, as well as other causes, very superior. The weights of the hammers of these machines range from 5 to 20 cwt.

Hammers for Jobbing Forges.

The framing of these machines is made so as to allow the workman the easiest possible access round the anvil. The great advantage of these hammers over the ordinary tilt hammers is, that the force of every blow can be varied to suit the work in progress, *a matter of great importance when only one hammer is employed.* A second advantage, which is also one of very great importance, is that the face of the hammer is always *horizontal*, thus saving all the time and trouble lost in adjusting the work done by tilt hammers. The weight of the hammers of machines for jobbing forges ranges from 1 to 7 tons.

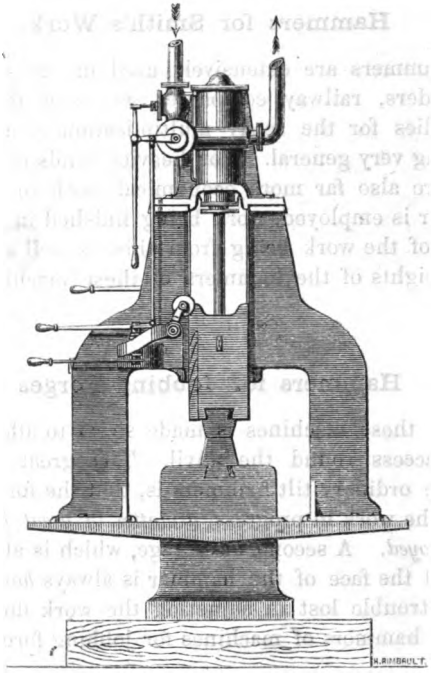
Hammers for Puddling Forges.

These machines are constructed especially for puddling and stabbing purposes, the anvils being very low, and effect an immense saving in the wear and tear of machinery, when compared with metal helves or squeezers. The weight of the hammers of puddling forge machines ranges from 1 to 4 tons.

Water Anvils and Hammer Faces.

These improvements, which have been already described, are mostly used in connection with hammers for puddling forges, but they may be adapted to any kind of hammer.

The following quotations apply to that class of steam hammers recommended by G. B. & Co., viz., those with *fixed cylinders*, combining simplicity of parts with the most complete command over the power of the machines. The illustration shows a hammer which may either be used as a *single* or *double-acting* machine, also as a self-acting one, or it may be worked by hand at a moment's notice.



The prices are exclusive of boilers, steam pipes, or any charges for fitting up.

Weight of Hammer.	Fall.	Price of Hammer alone.	Price of Anvils, Blocks, and Sole-plates.	Total.
	ft. in.			
5 cwts.	1 8			
7 „	1 10			
10 „	2 3			
15 „	2 9			
20 „	3 0			
30 „	3 6			
40 „	3 9			
50 „	4 0			
60 „	5 0			
80 „	5 9			
5 tons	6 0			
6 „	6 6			
7 „	7 6			

Larger hammers at prices proportioned to requirements.

Hammers up to 40 cwt. require not less than 25 lbs. steam pressure, 50 to 60 cwt. at least 30 lbs., and all above that weight not less than 35 lbs.

Working drawings of anvils, blocks, and sole plates are furnished to all purchasers of steam hammers, so as to enable them to make these parts themselves, if preferred.

CHAP. VII.—CORN OR FLOUR MILL MACHINERY.

CORN OR FLOUR MILL MACHINERY,

Of every description, including grinding machinery, wheat-cleaning and flour-dressing machines, &c., &c., adapted to be driven by steam, water, wind, or cattle power. G. B. & Co. contract to supply the whole apparatus, machinery and stores complete, required for corn mills of any size.

The following are the particulars of a steam corn mill lately manufactured by G. B. & Co. for the Cape of Good Hope—viz.,

One steam engine of 12 nominal horse-power, on the double cylinder expansive principle, and all fitted to an independent sole plate, with fly wheel 14 feet diameter, weighing 75 cwt., polished wrought-iron crank shaft, Cornish boiler, and all the usual pipes and fittings complete, in a first-class engine.

A set of flour mill machinery, consisting of four pairs best French burr stones, 4 feet diameter, fitted with turned wrought-iron spindles, and improved lifting and feed-regulating apparatus; framing of cast-iron, supported on ornamental cast-iron columns, fastened to a massive cast-iron sole plate. Gearing and shafting, elevators, creepers, and conveyors throughout the mill complete.

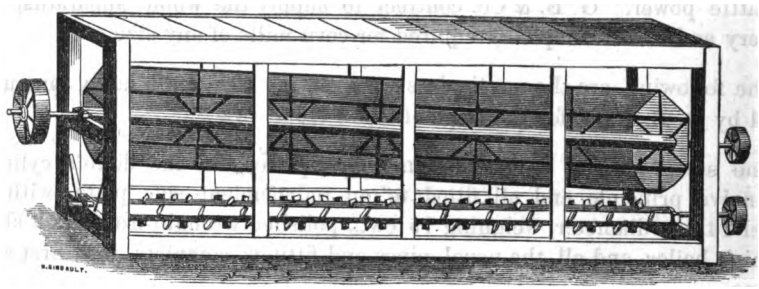
One flour-dressing machine, with iron cylinder, and frame fitted with brushes of best Russian bristles, &c., and silent feed motion.

One wheat-cleaning machine, on an improved principle, designed especially for taking the weevils out of Cape wheat, with blowing machine complete. The whole, properly packed and protected for shipment, delivered in London, price £ .

Patent Revolving Flour-dressing Machines,

With iron cylinder, 18 inches in diameter, fitted with outside circular brushes, &c., complete. These machines, from the great *accuracy* of their construction, and truth of the cylinder, are calculated to run for a long period, without even brushing the wire; indeed, millers have stated that there is a saving of fifty per cent. upon wire and brushes alone. They only require about 2½-horse power, and are fitted in a strong iron frame, with *feeder attached*, and partitions to divide the flour, bran, &c., all ready for bolting to the floor.

Silk Dresser, or Bolting Machine.



The above is a representation of a bolting machine, 18 feet long, with reel 3 ft. 3 in. diameter, and fitted with the best Swiss silks, in case complete. Is capable of dressing from 12 to 14 bushels per hour; speed, from 28 to 34 revolutions per minute. The *advantages* arising from the use of the silk mill are these—the *great saving of power*, as compared with the wire and brushes, avoiding the wear and breakages so often and justly complained of, and annoying to millers when flour is required, and being obliged to wait till the machine is taken to pieces and wire replaced; and it is moreover a great convenience in mills where there is not much room, as the flour can be dressed as ground, and can go into other stores instead of standing about in sacks.

Vertical Smut Machines.

MACHINE BRUSHES,

Made from the *best Russian bristles*, warranted all hair, in single, double, or treble grooves, with grey or white bristles. Also, *single and double cane brushes*, for smut machines.

Superior French Burr Stones,

Carefully selected from the best quarries in France, warranted to grind fast, cool, and with little friction.

Cast-steel Mill Bills and Chisels.

Cast Metal and Slate Provers,

For dressing stones, manufactured from the best silver steel, weighing from 2½ to 5 pounds each, carefully tempered at the point; also Thrifts, or Mill Bill Handles, made from the best seasoned ash, from 4 to 5 feet long, for proving millers' staffs, planed by machinery, and *warranted true*, in well-made oak or deal cases, and fitted with lock and key; also, Mahogany Stone Staffs, of various lengths, made from *well-seasoned wood*, composed of four different pieces, with the grain reversed, and strongly bolted together, with *brass-headed bolts*, thus securing strength and accuracy not obtainable in any other kind of staff.

Machine Wire,

For dressing and smut machines.

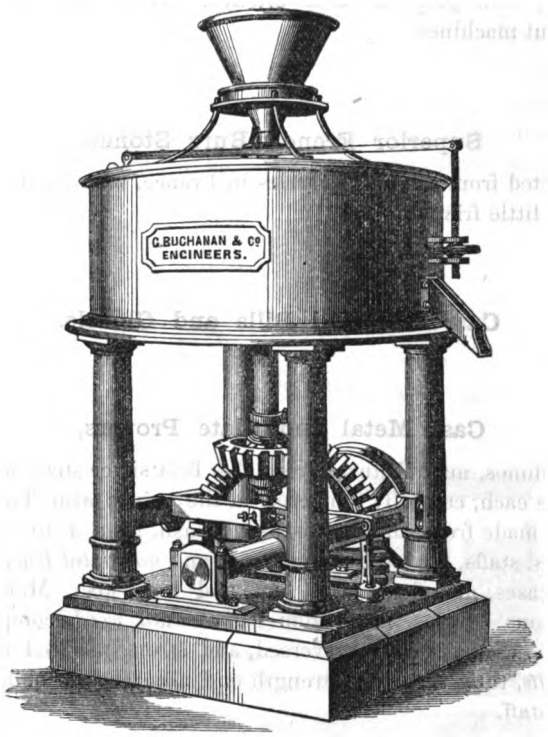
Proved Iron Hoisting Chains,

And every other description of millers' tools and apparatus; also,

Flour Bags.

PORTABLE CORN MILL,

FOR HORSE, STEAM, OR WATER POWER.



This valuable corn mill is well adapted for grinding all kinds of cereals. It consists of a strong iron frame, erected on substantial columns, the whole bolted to a strong iron foundation-plate, and requiring no fixing beyond a bolt in each corner.

There is a simple arrangement by which the stones may be readily adjusted to grind fine flour, or bruise oats, split beans, &c.

These mills are fitted with the best French burr stones, to grind wheat. A Derbyshire grey runner is, however, recommended to grind or kibble barley, &c. They are frequently fitted up with a complete dressing apparatus, neatly arranged in the framework of the mill.

Prices.

Diameter of Stones.	Price, if fitted with a pair of Derbyshire Grey Stones.	Price, if fitted with a pair of best French Burr Stones.	Price, if fitted with a pair of best French Burr Stones and a Derbyshire Grey running stone,	Extra if a Dressing Apparatus is supplied.	Power required to drive the Mill when Grinding and Dressing.	Quantity of Wheat the Mill will Grind and Dress per hour.
inches.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		Pounds.
18					1 horse	60
20					2 ditto	90
24					3 ditto	120
30					4 small do.	170
36					4 strong do.	200
42					5 horses	220
48					6 ditto	250

The power here alluded to is either animal, steam, or water, and the quantity stated is the average of 10 hours' work.

CHAP. VIII.—BRICK MAKING MACHINERY.

MACHINERY for the preparation of clay, and the manufacture of brick, tiles, &c., has been brought to very great perfection, so that these machines are now almost universally employed by Contractors, Builders, and others connected with works of any magnitude.

G. B. & Co. supply only those machines which have been proved by actual experience to be the most efficient, as well as economical in first cost, and subsequent maintenance.

Bricks made by these machines possess superior qualities over those made by the ordinary "hand-moulds." The mechanical arrangement of the machine secures the bricks being cut and moulded to one uniform size—the cutting apparatus (which is most simple in its construction) can also be adjusted to suit any size of bricks or tiles.

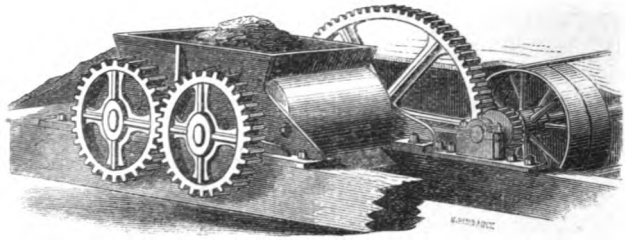
The quality of the clay, after being operated upon in the "pug mill," is much superior to the same when prepared by hand labour. In the former case, very little water is required to bring the clay into a proper consistency for moulding, and, consequently, a great saving of time and expense is effected in drying the bricks—in addition to the certain prevention of loss, so frequent from exposure on the drying "flats" during wet weather.

All the machines supplied by G. B. & Co. are prepared from the most approved designs, and made in a substantial manner, and each machine is thoroughly tested before leaving the works.

The following are a few of the machines now in general use for brick making:—

CLAY CRUSHING ROLLER MILLS,

To work by Steam, Water, or Cattle power.



To produce properly-manufactured articles of clay, it is indispensable that suitable and effective mechanical means be employed to prepare the raw material, according to its nature and the class of goods intended to be manufactured therefrom. The economical and rapid preparation of clays or earth for "solid brick" manufacture is, therefore, most important.

For rough stony clays especially—except limestone—or for hard unsoakable marls intended to be made into bricks, or other large coarse goods, the most effective, rapid, and economical preliminary means of preparation is that of "CRUSHING" them into a plastic state, by the employment of a powerfully-constructed ROLLER MILL, which reduces the entire mass of material into a fine state; prevents the possibility of unsoaked lumps of clay, stones, or other hard substances passing into the body of the machine; and effects that uniformity in condition, when so finely crushed, which is not only highly desirable to prevent the imperfect formation of bricks, or interruption to the regular operation of the moulding portion of the machinery, but is indispensably necessary with all such classes of clays, if intended for the production of sound, durable bricks, either by hand or machine moulding. In short, the many advantages attendant on the adoption of "crushing rollers," in conjunction with brick making machines, can scarcely be too strongly urged.

"A" size machine, capable of crushing sufficient rough clay and materials to produce 10,000 bricks per day.....price £

"B" size machine, capable of crushing sufficient rough clay and materials to produce 20,000 bricks per day.....price £

"C" size machine, capable of crushing sufficient rough clay and materials to produce 30,000 bricks per day.....price £

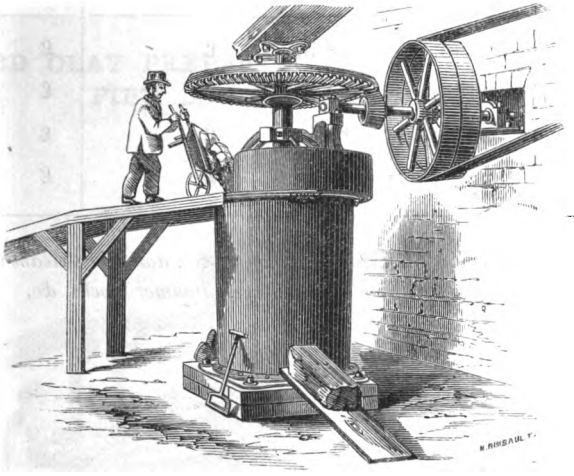
The above prices include packing and delivery for shipment.

"Crushing mills" of any other size, differing from the above, made to order.

IMPROVED "ARCHIMEDIAN" KNIFE PUGGING MILL,

To work by Steam, Water, or Cattle power,

FITTED WITH GEARING AT THE TOP OF OR UNDERNEATH THE MILL AT OPTION.



In the preparation of clay for *every description of goods*, the next, and in some instances the first, important machine process is that of pugging; and it may be truly said that the PUG MILL is one of the most useful and essential implements in brick and tile manufacture. The object of pugging the clay is to bring it into a complete homogeneous state of consistency. In the clay as dug, (with rare exceptions) the strata are various. In some portions the unctuous; in others, the sandy, silicious, or other qualities prevail. In order to work this clay properly and effectively, it is indispensably necessary to incorporate its various component parts, and to make it of one *uniform character*. The **pug mill** is, therefore, the most valuable and important precursor of the subsequent processes of brick as well as of tile manufacture, inasmuch as the equal consistency and integrity of the raw material can alone insure the uniform strength and good quality of the completed brick or tile. The Improved Archimedian Knife Pug Mill has achieved these desirable results, which the method of preparing the clay previously in use could not obtain.

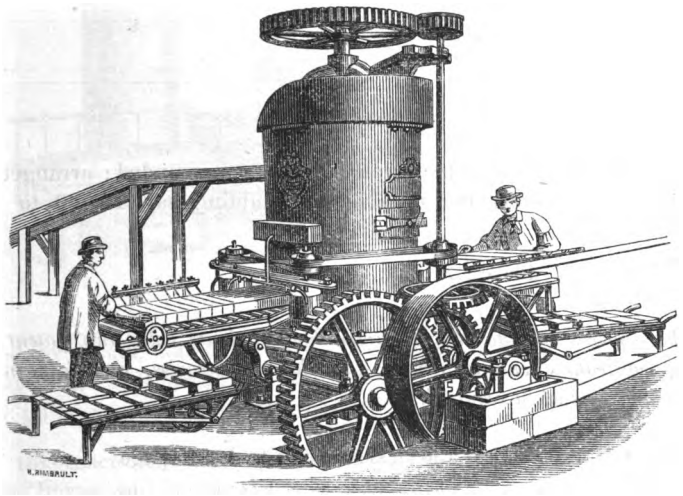
The knives in this mill being set upon the Archimedian principle, not merely cut the clay, but also turn it over in each revolution, so that every part of the clay is submitted to their action; and (being furnished with

scrapers or cleansing knives) clogging at and adhesion to the sides of the mill is completely prevented, friction diminished, and the whole mass of clay thoroughly and completely amalgamated.

Size of Machine.	Diameter of Cylinder.	Height of Cylinder.	Price, fitted with Cattle Gear.	Price, fitted with Gearing for Steam or Water power.
A	24 in.	48 in.	£	£
B	24 in.	54 in.	£	£
C	26 in.	60 in.	£	£
D	28 in.	66 in.	£	£

The above prices include all holding-down bolts, &c., and when steam or water power is used, fast and loose pulleys, plummer blocks, &c.

COMBINED CLAY PREPARING, AND BRICK, TILE, AND PIPE MAKING MACHINE.



These machines are arranged to perform the *two* operations of preparing the clay and making it into bricks—so that the separate "Pugging Mill" is dispensed with. To the larger size machines the "Clay Crushing Mill" (before described) is also occasionally attached, so that the raw clay is converted into bricks by a continuous process, and the labour of passing the clay from one machine to the other saved. The clay issues alternately from the opposite sides of the machine in rectangular blocks, and is then separated by cutters into bricks of the required dimensions. The peculiar arrangement of the "dies" ensures the uniform regularity of "form," and smooth surface of the bricks, which have clean and sharp angles.

By changing the "dies," bricks, tiles, and pipes of any required section may be produced.

Size of Machine.	Number of Bricks capable of moulding per day.	Number of Horses power required to work each Machine.	Price of combined Machine with Gearing and Pulleys (exclusive of Steam Engine).	Extra, if fitted with Crushing-mill.
A	12,000 to 15,000	5	£	£
B	18,000 to 25,000	7	£	£
C	30,000 to 35,000	10	£	£

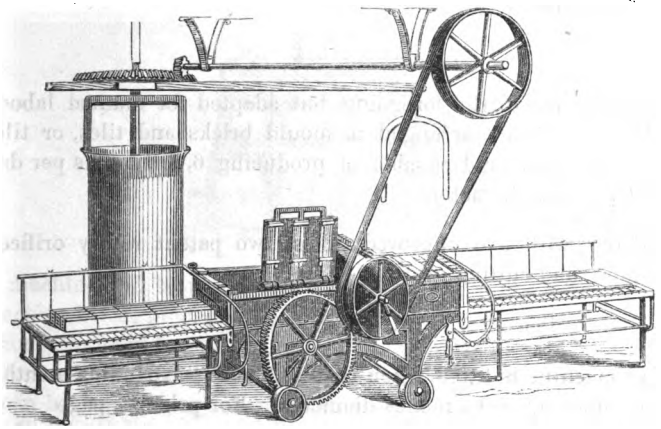
A smaller machine is also made, and much recommended; arranged to be worked by cattle power, and capable of moulding say 10,000 to 12,000 bricks per day.

Price ..... £

The above prices include the necessary holding-down bolts, two patent rotary brick dies, lubricators, cutting frames and their accessories, and fast and loose pulleys on machines when required.

For dies of different sizes and designs, and tools, *see* page

PORTABLE DOUBLE ACTION BRICK, PIPE, AND TILE MAKING MACHINE.



Worked by steam, water, or cattle power, and arranged, in conjunction with "Pug mill," with horizontal shaft, bevel gearing, plummer blocks, fast and loose pulleys for forward and backward motion.

When this machine, combined with the "Pug mill," is worked by animal power, two horses will be found amply sufficient to keep the entire machinery going at full power.

This machine will mould bricks and tiles, or tiles and pipes, at one operation, and deliver from 7,000 to 8,000 bricks per day.

By the arrangement of suitable dies, this machine will produce pipes up to $6\frac{1}{2}$ *inches diameter, and by the addition of "expanding mouth-piece," with dies, table, and stool, will mould pipes up to* 15 *inches diameter.*

The above machine, with "Pug mill," shafting and connexions, and with two improved tables and cutting gear, and two patent rotary orifice brick dies, lubricators, &c., complete,

Price ..... £

Dies for bricks and tiles, and mandril pipes made to order; for prices *see* page

A perforated screen is an exceedingly useful adjunct to this machine, to separate the clay from all stones, &c., which would be inadmissible in the clay for pipe making.

Price ..... £

A set of tools necessary for each machine, and comprising picker, chisel, scraper, key, and spade.

Price ..... £

A machine similar to the foregoing, but adapted for manual labour, and without "Pug mill." and arranged to mould bricks and tiles, or tiles and pipes, at one operation, and capable of producing 6,000 bricks per day, and pipes up to 6½ inches diameter.

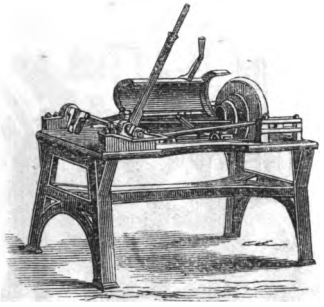
This machine, with two improved tubes, two patent rotary orifice brick dies, lubricators, and cutting gear.

Price ..... £

The above machine is fitted, when required, with "expanding mouth-piece" for moulding pipes up to 15 inches diameter. For price *see* page

PORTABLE HORIZONTAL PIPE SOCKET MACHINE.

(Worked by Hand.)



This machine will be found very useful in conjunction with the "Portable double-action brick, pipe, and tile making machines." It receives the pipes direct from the moulding machine, and by its mechanical arrangement immediately forms the "socket" on one end of the pipe; the form and design of socket can be made to any shape that may be required, by the introduction of suitable dies.

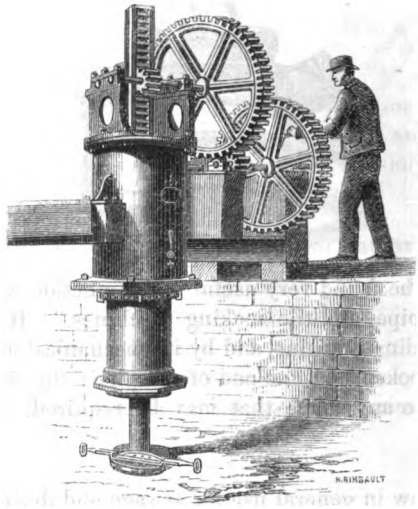
These pipes are now in general use for sewage and drainage purposes.

Price (exclusive of dies) £

Small vertical machines, for same purpose as above, and with adjustment to suit different lengths of pipes, made to order.

VERTICAL PIPE MAKING MACHINES.

Constructed for working by Hand, Steam, Water, or Cattle power.



A machine to be worked by manual labour, capable of making "plain" pipes from 3 inches to 18 inches diameter, and "socket" pipes up to 15 inches diameter, including hydraulic receiver and elevator.

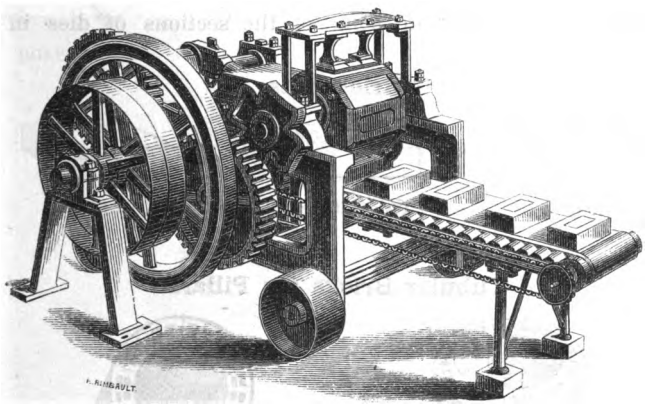
Price (exclusive of dies) £

A larger machine, to be worked by manual labour, capable of making "plain" pipes from 3 inches to 24 inches diameter, and "socket" pipes up to 18 inches diameter, including hydraulic receiver and elevator.

Price (exclusive of dies) £

SELF-ACTING ROTARY BRICK PRESSING MACHINES.

For Steam or Water power.



These machines are highly recommended and are now in very general use. The bricks so subjected to pressure are much preferred by builders for facing walls; and being quite square and smooth, require less mortar or cement between joints.

The almost entire absence of moisture in the bricks after compression reduces to a very considerable extent the time usually occupied in drying in kilns.

The moulds generally fitted to these machines are for the usual size of bricks, viz, 9½ to 10½ inches long, and 4½ to 5 inches wide—but any other moulds of different sizes can be supplied with the machine.

A machine to press from 10,000 to 15,000 bricks per day,

Price ..... £

A smaller machine, to be worked by manual labour, and capable of producing 6,000 bricks per day,

Price ..... £

Spring carriers-off for ditto, per pair ... £

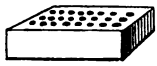
BRICK, TILE, AND PIPE DIES.

These are made in endless variety, sizes, and designs, according to requirements and size of machine.

The following will illustrate some of the sections of dies in general demand:—

Brick Dies,

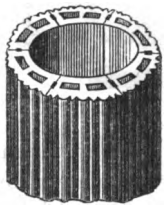
HOLLOW.

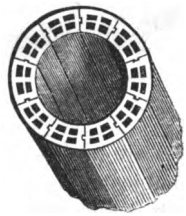


PERFORATED.

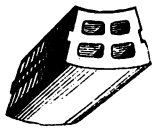
TUBULAR.

Tubular Bricks for Pillars.





Sectional Tile for Culverts.



Roofing Tiles.

PLAIN.

CORRUGATED.

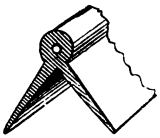
SPANISH.

TAPER.

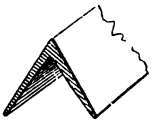
PAN.

IMPROVED CORRUGATED.

Ridge Tile Dies.



ROLL TOP.



PLAIN.

GOTHIC TOP.

Paving Tile Dies in all designs.

PIPE DIES FOR DRAINAGE.

Plain round; socket end; round tiles, with flat bottoms; D tiles; channel gutter tiles; drain bricks, for pavements.

Mandrils for pipes, bricks, &c., to suit shape of dies.

Wooden mandrils, or carriers-off, for pipes under 4 inches, £

,,	,,	,,	5	,,
,,	,,	,,	6	,,
,,	,,	,,	7	,,
,,	,,	,,	8	,,
,,	,,	,,	9	,,
,,	,,	,,	10	,,
,,	,,	,,	11	,,
,,	,,	,,	12	,,
,,	,,	,,	13	,,
,,	,,	,,	14	,,
,,	,,	,,	15	,,

Mill for cutting clay.

Cloth for table bands and rollers.

CHAP. IX.—HYDRAULIC AND SCREW PRESSES.

Hydraulic Presses.

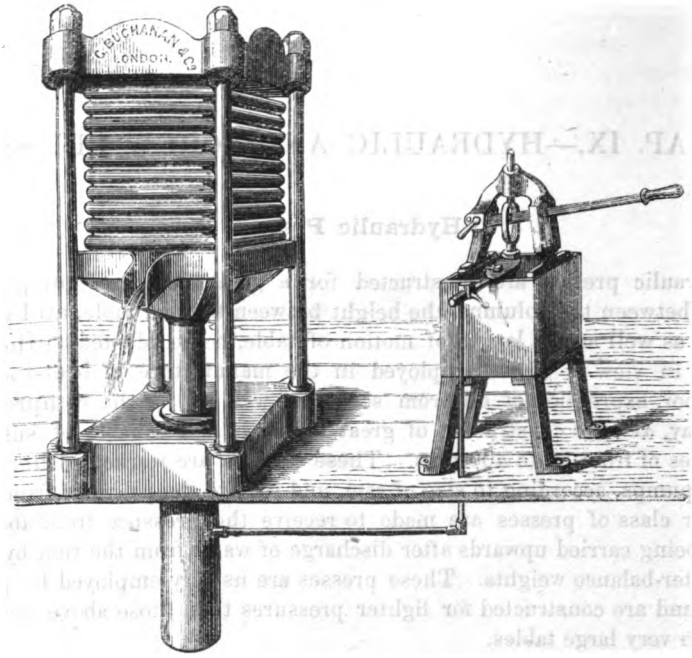
Hydraulic presses are constructed for a great variety of purposes, the widths between the columns, the height between top and table, and diameter of ram, as well as the length of motion of table, being adapted to the special objects in view. Those employed in the manufacture of beet-root sugar and paper, expression of oil from seeds, as well as for the compression of wool, hay, &c., are constructed of great strength, and capable of sustaining pressures of from 50 to 400 tons. These presses are worked either by one or two pumps, according to size of ram, and receive the pressure from below. Another class of presses are made to receive the pressure from above, the tables being carried upwards after discharge of water from the ram by means of counter-balance weights. These presses are usually employed for packing goods, and are constructed for lighter pressures than those above described, but with very large tables.

For special purposes, the presses require entire fittings to adapt them to perform their work in the most efficient manner. The following prices are, however, for plain presses similar in construction to that shown in the illustration, but of various sizes. The following table applies to presses of the strongest kind, or those first named.

Sizes.	Diam. of Rams, in ins.	Rise of Table, in ins.	Size of Table, clear space between columns in ins.	Height between head & table in ins.	Number of Pumps.	Pressure in tons.	Price.
1	4	18	26 × 20	48	Single	50	£
2	6	18	26 × 20	48	„	80	
3	7	24	28 × 22	48	Double	150	
4	8	18	28 × 24	48	„	200	
5	10	30	31 × 24	48	„	350	
6	12	20	28 × 24	48	„	400	

Presses of any other size at proportionate prices.

The pumps of these presses may be adapted to be worked by steam, water, or animal power, at a cost of from £ to £ in addition to the prices above given.



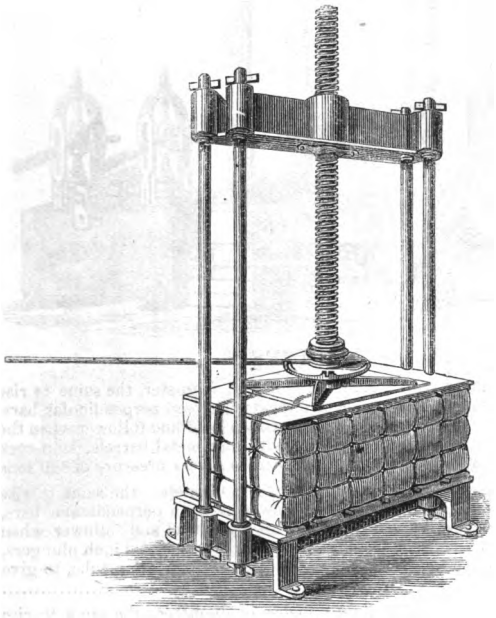
The following table applies to the particular kind of presses adapted for packing goods.

Sizes.	Diameter of Ram, in ins.	Rise of Table, in ins.	Width between pillars, in inches.	Height between head & table, in feet.	Number of Pumps.	Price.
1	4	33	48	5	Single	£
2	5	36	63	6	,,	
3	6	36	78	7	,,	
4	8	48	84	7	Double	
5	10	48	84	7½	,,	

Presses of any other size at proportionate prices.

Screw Presses.

These presses are made entirely of iron, are of simple construction, easily taken to pieces and packed for shipment. They are fitted with wrought iron turned screw, 6 feet long by 4 inches diameter, with bed 4 feet 2 inches long by 2 feet wide, the height between head and table being 6 feet 6 inches. They are suitable for hay, cotton, wool, oil, &c., &c.



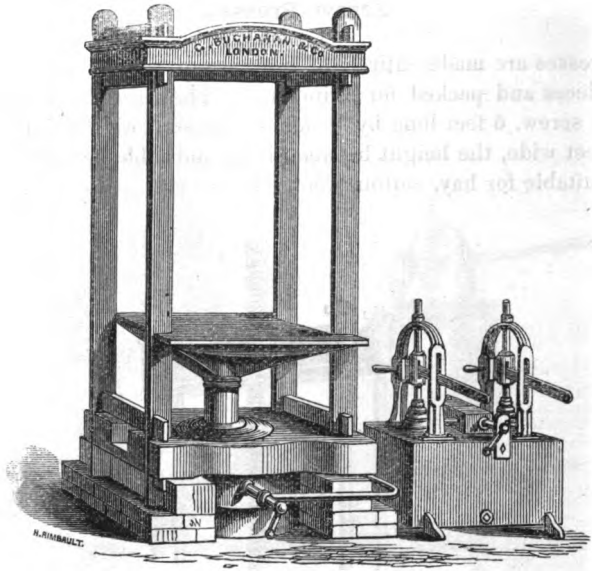
Price, complete, with two levers, £

Two men can give a pressure of 40 tons.

Larger presses at proportionate prices.

Hydraulic Presses.

Specially adapted for compressing Cotton, Wool; extracting Oils, Juices, &c. They are fitted with *Single* or *Double* Pumps, and made in a very strong and superior manner. Their simplicity of construction enables any person of ordinary capacity to erect and take the entire management of them, assisted by our instructions, which accompany each Machine.



PRICES.

No. 1. Hydraulic Press, fitted with a Ram 12 inches in diameter, the same to rise 20 inches, with clear space on table or follower between perpendicular bars, 28 inches by 24 inches; extreme opening between head and follower when the Ram is down, 48 inches. Double pumps, with gun-metal barrels, stop-cock to bed, and wrought connecting tube, adapted to give a pressure of 400 tons

No. 2. Hydraulic Press, fitted with a Ram 10 inches in diameter, the same to rise 30 inches, with clear space on table or follower between perpendicular bars, 31 inches by 24 inches; extreme opening between head and follower when the Ram is down, 48 inches. Double Pumps, of 1 inch and 2 inch plungers, gun-metal barrels, stop-cock to bed, and wrought connecting tube, to give a pressure of 350 tons.....

No. 3. Hydraulic Press, fitted with a Ram 8 inches in diameter, the same to rise 18 inches, with clear space on table or follower between perpendicular bars, 28 inches by 24 inches; extreme opening between head and follower when the Ram is down, 48 inches. Double Pumps, with gun-metal barrels, stop-cock to bed, and wrought connecting tube, to give a pressure of 200 tons ...

No. 4. Hydraulic Press, fitted with a Ram 7 inches in diameter, the same to rise 24 inches, with a clear space on table or follower between perpendicular bars, 28 inches by 22 inches; extreme opening between head and follower when the Ram is down, 48 inches. Double Pumps, with gun-metal barrels, connecting pipe, and stop-cock complete, adapted to give a pressure of 150 tons .....

No. 5. Hydraulic Press, fitted with a Ram 6 inches in diameter, the same to rise 18 inches, with clear space on table or follower between perpendicular bars, 26 inches by 20 inches; extreme opening between head and follower when the Ram is down, 48 inches; with Single Pump, gun-metal barrel, stop-cock, and connecting-pipe, adapted to give a pressure of 80 tons .....

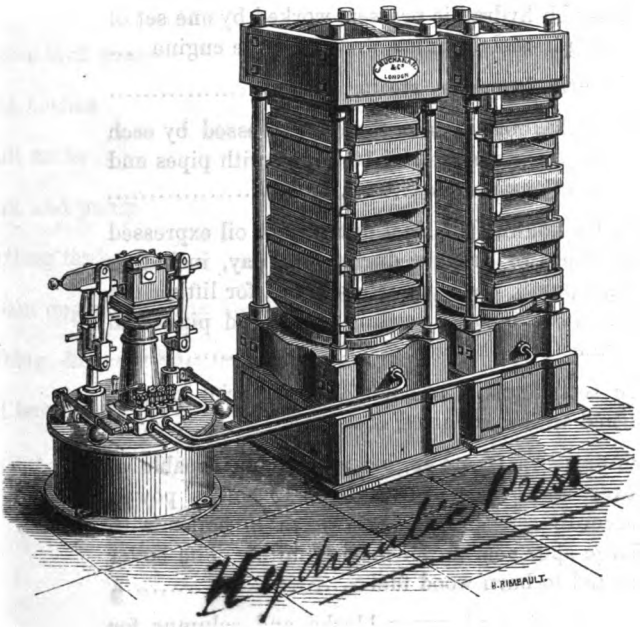
No. 6. Hydraulic Press, fitted with a Ram 4 inches in diameter, the same to rise 18 inches, with clear space or follower between perpendicular bars, 26 inches by 20 inches; extreme opening between head and follower when the Ram is down, 48 inches. Single Pump, with gun-metal barrel, stop-cock, and wrought connecting-pipe, adapted to give a pressure of 50 tons.....

The above dimensions are only given to convey an idea of the different sizes made: but should alteration be required, it can be done at a trifling cost, and perhaps without extra charge.

The Presses can be constructed to work by Steam, Water, or Animal Power, the cost being from £ to £ in addition to the above prices.

CHAP. X.—STEAM OIL MILLS.

FOR EXTRACTING LINSEED AND OTHER OILS FROM SEEDS.



In these combined mills the first operation consists in passing the seed through a *screen*, which removes the dirt.

In the second operation it is passed through a pair of powerful cast-iron *crushing rollers*, which bruise or crush it.

The third operation consists in grinding the seed under a pair of *edge stones*, weighing together about seven tons, after which it is heated to 170° Fahrenheit in the *steam kettle*, from whence it is withdrawn and placed in bags ready for being put into the hydraulic presses.

These are specially constructed for expressing oil in the most effectual manner, and the pumps are worked by the steam engine. The pressure exerted by each press is 800 tons.

The oil, on leaving the seed, flows through the bags into the tanks, and the dry cake remains.

The following is the cost of a mill of this description, suited to express about 1½ tons of oil* per day of ten hours, from a good average quality of linseed.

1 seed screening machine and driving apparatus..... £

1 pair of powerful seed crushing rolls, and gearing...

1 pair of edge stones, 7 ft. 6 in. diam., and together weighing about 7 tons.....

2 twelve-inch hydraulic presses, worked by one set of best gun-metal pumps, driven by the engine ...

1 seed kettle, heated by steam .....

2 spell tanks, for holding the oil expressed by each press, during a spell of 10 hours, with pipes and connections thereto .....

1 tank, for holding the total quantity of oil expressed by the two presses during one day, including a lift pump, worked by the engine, for lifting the oil into the large settling tanks, and pipes and connections thereto .....

1 large settling tank, to hold 2,000 imperial gallons, fitted with drawing-off cocks, &c. .....

1 high-pressure steam engine and boiler, capable of exerting a power of from 10 to 15 horses' power, according to pressure of steam in boiler, with large spur gearing for driving mill. The boiler suited to burn wood fuel.....

Shafting, gearing, plummer blocks, and columns for supporting floor of mill and carrying shafting, including necessary gearing for driving kettle and hydraulic pumps; also one sack hoist, and driving apparatus for the same .....

Seed bags, small fittings, and erecting tools and materials, &c. .....

Packing cases and packing.....

£

N.B.—A mill of this size would require about 6 men to attend to it, including engineer and stoker.

* This quantity of oil would be equal to a consumption of about 23 quarters of linseed per day. The cake produced would weigh about 3¼ tons.

Cost of a larger mill, to express double the quantity, or 3 tons of oil per day of 10 hours, consisting of

1 seed screening machine	(as before)	£
1 pair seed rolls	,,	
1 pair edge stones	,,	
4 twelve-inch presses	,,	
2 seed kettles	,,	
4 spell tanks	,,	
1 tank and pump	(larger)	
2 settling tanks	(as before)	
1 steam engine, of from 13 to 20 horses' power		
Shafting, &c., and hoisting tackle		
Seed bags, &c.		
Packing cases and packing		
		£

N.B.—A mill of this size would require about 8 *men to attend to it, including engineer and stoker.*

CHAP. XI.—WOOD CUTTING MACHINERY.

THE introduction of rough machinery for the conversion of wood dates from a very early period, but the more refined applications of it may be said to be inventions of the present day. In America, owing partly to the scarcity of labour, and partly to the cheapness of material operated upon, and the indifferent quality of the work required, this class of machinery made for a time more rapid advances than in England; but the quality of the work now performed by English wood-working machinery is universally acknowledged to be greatly superior to that produced by those of American manufacture.

The operations necessary for the conversion of timber may be all classed under the two heads of *sawing* and *planing;* the former being performed either by reciprocating saws fixed vertically, revolving circular saws, or endless band saws; and the latter by reciprocating or fixed planes, or horizontal and vertical rotatory cutters.

The main conditions to be fulfilled, in order to produce good work in wood-converting machinery, are *a high velocity of cutters, not too rapid travel of work, a solid bed to cut against, the working parts well balanced, the bearings steady, and the angles of the cutters properly determined.*

The number of machines constructed for converting timber, and shaping and finishing wood work, are exceedingly numerous, some being adapted only for special trades, others only capable of being usefully employed in dock-yards and arsenals, while others, again, are of general application. To the latter, the following list of prices applies.

The whole of the machines quoted for in the following lists are constructed of iron framing throughout, thus giving great rigidity and steadiness, and contrasting favourably with American machinery, in which the framework is ordinarily of wood. Great care is also taken to thoroughly *balance the machinery*— a matter of great importance in all machines working at a high speed; but perhaps of the greatest in those for finishing wood, as any vibration or unsteadiness immediately tells upon so yielding a material.

With regard to the speed of circular saws, it must be varied to suit the different classes of work, reaching to and sometimes exceeding 7,500 revolutions per minute, for some kinds. In the machines quoted for below, and for general work, a speed of 1,200 revolutions per minute is considered sufficient. In some large building establishments, the speed adopted for circular saws has been 6,000 revolutions per minute; but the men working the machines greatly prefer a lower speed, not exceeding the half of this, or 3,000 per minute.

With regard to the duty done by planing machines, those with fixed planes, and the board travelling at a sufficient speed, can finish from 50 to 60 feet per minute, and at this rate from 5,000 to 8,000 feet of flooring board can be produced in a day.

VERTICAL SAW FRAMES.

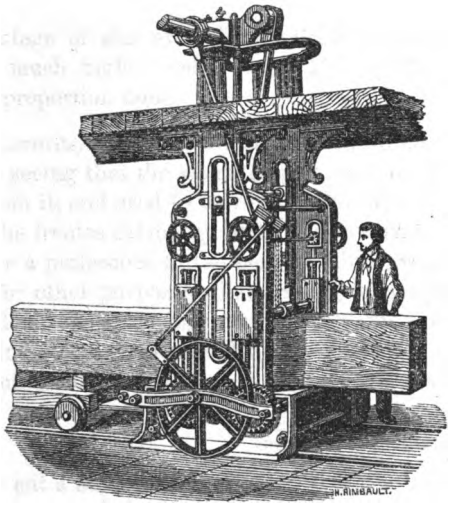
Vertical saw frames, for cutting up logs, are made of two kinds, viz. :—

Frames driven by Belts from stationary or portable engines, or any other power ; and

Direct-Acting Steam Saw Frames, with the engine and saw frame combined in one machine.

Frames driven by Belts.

These are subdivided into two varieties, viz., frames with the driving shaft placed above the saws on the top of the machine, and those with it placed below. The cost of both kinds is the same. The following sketch shows that variety with the driving gear placed above.



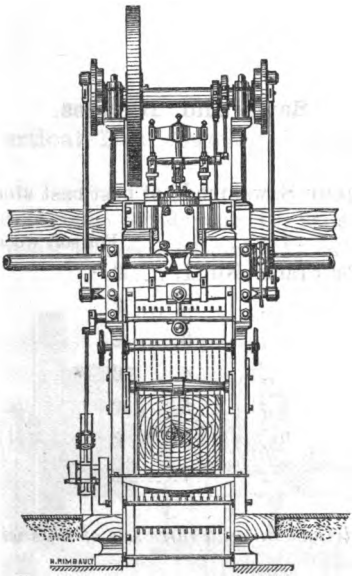
The following are the prices of the different sizes of machines all complete, excepting the saws and buckles, for price of which see page 6 of this chapter.

Prices of vertical saw frames, driven by belts either from above or below, with and without the driving power.

	Nominal H.P. of Engine.	Price of Saw Frame only.	Price of Saw Frame, Portable Engine, and Driving Belts, complete.
No. 1. To cut a 36-inch log ...		£	£
2. „ 30 „ ...		£	£
3. „ 28 „ ...		£	£
4. „ 26 „ ...		£	£
5. „ 24 „ ...		£	£
6. „ 22 „ ...		£	£
7. „ 20 „ ...		£	£

These machines are driven at about 120 *cuts per minute. Sizes Nos.* 5, 6, *and* 7 *are fitted, when required, with additional appliances for cutting deals into boards, at a cost of about* £ *extra. Two deals may be cut at one time. The whole of these machines are fitted with silent feed motion.*

Direct-Acting Steam Saw Frames.



The chief advantage of this system over the belt frames is that the saws can be driven at a much higher speed (from 170 to 210 cuts per minute), and more work in proportion done.

It is doubtful, however, whether they are, on the whole, as well adapted for Colonial purposes, seeing that the steam engine part of the machine cannot be disconnected from it, and used to drive any other description of machinery, as in the case of the frames driven by belts. In ordering, therefore, it might be advisable to give a preference to the belt machines, with the view of using the steam engine for other purposes when sawing was not required; unless it should be intended to keep the saw frame CONSTANTLY AT WORK, in which case the direct-acting steam frames might be preferred.

Price of direct-acting steam saw frames, exclusive of saws and buckles.

		Price of Saw Frame and Engine complete, without Boiler.	Extra for Boiler, with Mountings, Pipes, and Connections to Engine.
No. 1.	To cut a 36-inch log...	£	£
2.	„ 30 „ ...	£	£
3.	„ 28 „ ...	£	£
4.	„ 26 „ ...	£	£
5.	„ 24 „ ...	£	£

Saws and Buckles.

FRAME SAWS, made of best cast steel.

	For soft wood.	For hard wood.
A set of 12 saws for Frame No. 1. ...	£	£
,, ,, 2. ...	£	£
,, ,, 3. ...	£	£
,, ,, 4. ...	£	£
,, ,, 5. ...	£	£
,, ,, 6. ...	£	£
,, ,, 7. ...	£	£

N.B.—It is advisable to send three sets of saws with each frame.

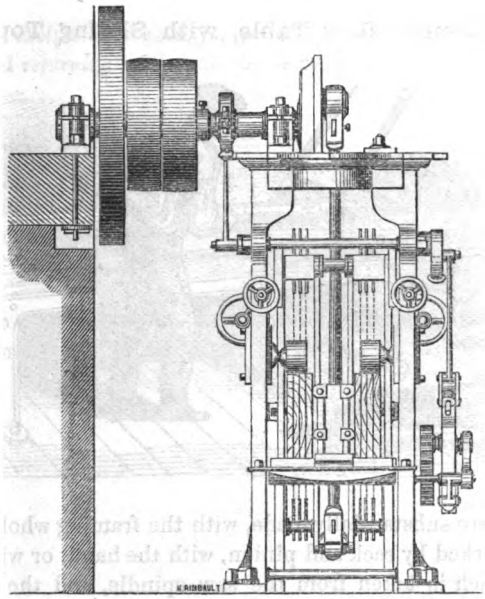
FRAME SAW BUCKLES, with steel cutters, for log frames.

Price per set, for one saw.

N.B.—These buckles are made to suit each size of frame.

Vertical Deal Sawing Frames.

A vertical deal saw frame, for driving by belts from above or below, capable of cutting two deals at once, each up to 5½ inches thick, and 24 inches broad.



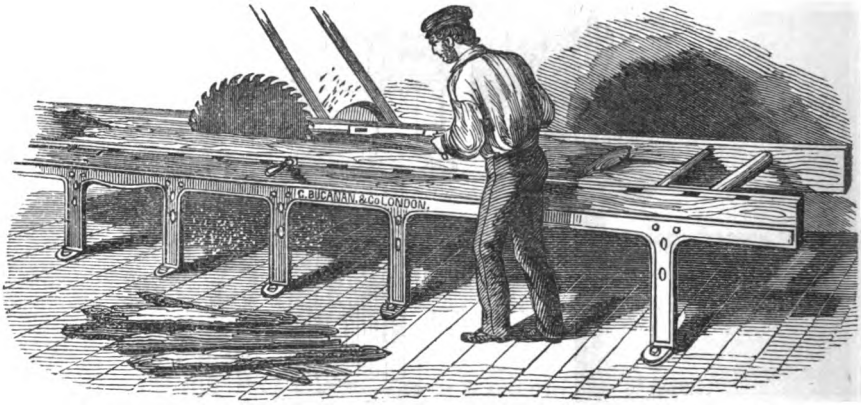
Price (exclusive of saws and buckles, for price of which see p. 6) ... ... £

This deal frame requires about 5-horse power to work it, at from 100 *to* 150 *cuts per minute.*

CIRCULAR SAWS.

These are extremely useful for sawing up timber for building purposes, or cutting wood for fuel, &c. They may be driven by a strap from a fixed steam engine, or from an independent portable engine, for prices of which see Chapter I.

Circular Saw Table, with Sliding Top.



These tables are substantially made, with the framing wholly of iron. The sliding top is worked by rack and pinion, with the hand, or with the self-acting feed motion, which is taken from the saw spindle, and the whole complete, ready for the belt.

1st Size, to cut lengths of 26 ft., with two saws, one 30 in. and one 36 in. diameter ... ... £
2nd Size, to cut lengths of 20 ft., with ditto ditto ... £
3rd Size, ,, 14 ft., with ditto ditto ... £
*** When the self-acting feed motion is furnished, £ extra.

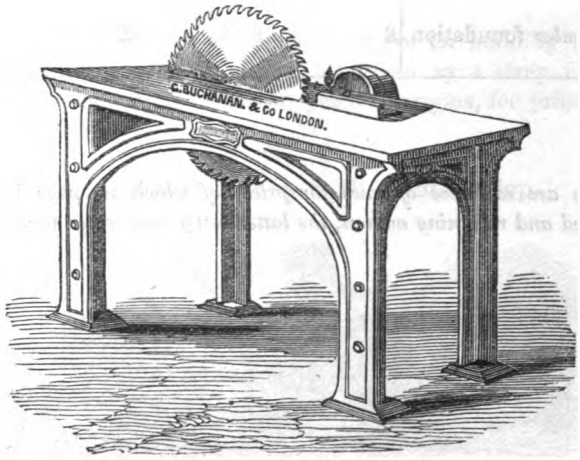
The following are the prices of a more powerful description of machine than the above, requiring a steam engine of 8-horse power to drive it. The

saw is 5 feet diameter, and should be driven at 1000 revolutions per minute. They are constructed differently, for STONE or TIMBER foundations.

To cut Timber.	18½ ft. long.	27 ft. long.	34 ft. long.	41 ft. long.
Circular saw travelling table, for *stone* foundation, 60-inch saw ...	£	£	£	£
Ditto, for *timber* foundation.	£	£	£	£

The prices are exclusive of saws, for prices of which see page 12*; but include self-acting feed and returning motion, the latter being accelerated to save time.*

Circular Saw Table, with Fixed Top.



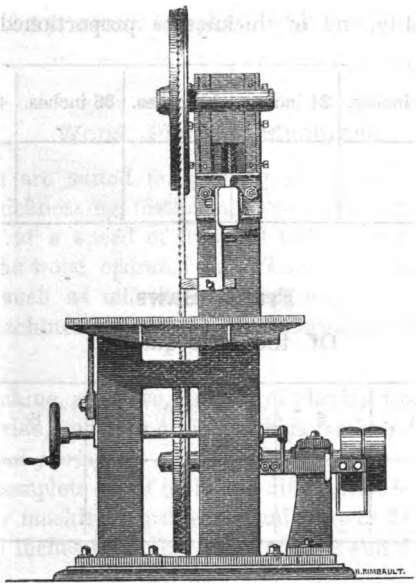
This table is adapted for cutting short lengths, and all sorts of jobbing work, which cannot be so conveniently done with the long table and sliding top. Both framing and top are made of cast-iron. The top is planed perfectly level, to insure the wood being cut with the most perfect accuracy. The table is complete, with guide or fence, and has a fast and loose pulley ready for the belt.

Size No. 1. To take in a 36-inch saw ... ... £
,, 2. A handy jobbing bench, to take in a 30-in. saw £
,, 3. To take in a 24-in. saw... ... ... £

These prices are exclusive of saws, for prices of which see page 12. *No.* 1 *may be supplied with self-acting rope feed motion at £ extra, and with a travelling carriage and rails to assist in guiding and carrying the weight of trees and other large pieces of timber, at £ extra.*

Any of the machines may be fitted with boring apparatus at the end of the spindle of driving pulley, which is found very useful for boring holes in fencing, &c. Extra cost (including 4 boring bits), £

Endless Band Sawing Machines.



These valuable machines are especially suited for *curved* work, the most elaborate patterns being cut out by them. They are capable of cutting wood 12 in. to 16 in. thick, into any shape, the wood being turned by hand in any direction while being sawn. As the dust from these machines is not thrown out, the lines for the work can be accurately kept to. Little or no wood is wasted by their use.

Diameter of Pulleys.	18 inches.	24 inches.	30 inches.	36 inches.	42 inches.
Prices	£	£	£	£	£

The prices are exclusive of saws, for price of which see page 12.

SAWS, &c.

Circular Saws

Of the best quality, and of thicknesses proportioned to diameters.

Diameter.	18 inches.	24 inches.	30 inches.	36 inches.	48 inches.	60 inches.
Prices						

Frame Saws

Of the best quality.

Length in feet.	4	5	6	7	8	9	10
Price... ...							

Endless Band Saws

Of the best-tempered steel.

Width in inches.	Up to $\frac{1}{4}$-inch.	$\frac{5}{16}$ to $\frac{1}{2}$-inch.	$\frac{9}{16}$ to $\frac{3}{4}$-inch.	$\frac{13}{16}$ to 1 inch.	$1\frac{1}{16}$ to $1\frac{1}{4}$ inch.	$1\frac{5}{16}$ to $1\frac{1}{2}$ inch.	$1\frac{9}{16}$ to 2 inches.
Price per foot.							

Saw Punching Machine,

Complete, £

Cast steel punches or clip for ditto, £

Grindstone Trough.

To take in a 4 ft. stone, with spindle, fast and loose belt pulleys, and handle complete ... ... £

Set Stone Trough,

With Water of Ayr stone, complete, with fast and loose belt pulleys ... ... £

Wood Planing Machines.

These machines are suited for planing planks of all kinds, or flooring boards (planing, thicknessing, feathering and grooving, or plain edging, all at one operation), at a speed of from 40 to 70 feet per minute, according to the nature of the wood operated on. They are also capable of making large mouldings, such as taffrails and waterways for ships' decks. When required, these machines are fitted with differential gear for working hard or soft wood.

Price of a machine, as above, capable of planing from 8 to 12 inches wide, and ¼ to 4 inches thick (*exclusive of tools and differential gearing*) ... ... £
Price of one complete set of tools and differential feed gear £
Price of larger machine, capable of planing up to 24 inches wide, and 6 inches thick (exclusive of tools and differential gearing) ... ... £
Price of one complete set of tools and differential feed gear £

Wood Moulding Machines.

These machines will make every form of moulding for house, cabinet, or ships' work, and are also adapted for planing light boards.

Price of the above (exclusive of moulding or planing irons) £

Mortising Machines,

Of any size and capability required, at prices according to specification.

Tenoning Machines,

Of any size and capability required, at prices according to specification.

PORTABLE SAWING MACHINERY ON WHEELS.

This apparatus consists of a vertical saw frame mounted on wheels, and fitted with shafts for horses, so as to be readily moved from place to place. It is driven by a belt from an ordinary portable engine, which, of course, is also easily moved with it. The engine and saw frame are thus adapted for being taken to the spot where the timber is felled, and where it may be squared up, or cut into deals at once, thus saving the cost of transit of the extra weight of the rough logs, while the sawn timber is easier of carriage than the logs would be.

Prices about per cent. higher than the vertical frames driven by belts, with portable engines complete, specified in page 4.

SAW MILLS.

The particular arrangement and construction of saw mills must always be greatly influenced both by the locality in which they are situated, the kind of timber to be converted, and the purposes for which it is intended to prepare it. On these accounts, it is hardly possible to give more than has already been done (viz., prices of the various sizes of the different machines, and the power necessary to work them) towards assisting those desirous of establishing saw mills. A few observations may, however, prove useful to those ordering sawing machinery, relative to the general arrangement of saw mills, and the most useful kinds of machines. These consist of the following.

Vertical Saw Frame.

The first point to be considered is the size of the timber to be converted, and care should be taken to select a frame saw sufficiently wide to take in logs of the *largest* size *generally* met with; and also to allow for bends in them, if they usually exist; a few additional inches in width not greatly increasing the cost. Any timber of *exceptional* size may be roughed by the circular saw, or by hand, before going into the frame. The two smaller sizes are adapted for deal sawing, and when either of these frames is employed, a separate deal frame is not generally required.

Deal Saw Frame.

These machines are usually made of one size only. They are capable of cutting two deals at once, and if an average quantity of work can be found for the vertical frame above referred to, or if this machine is one of the larger kinds, a separate deal saw frame will be found very convenient. At the same time, they can be dispensed with when the smaller vertical frame is the only one used, as it can be easily adapted to cut deals.

Planing Machine.

The size of this machine will depend upon the nature of the work done, the smaller one planing timber up to 12 inches wide, and 4 inches thick, and the larger up to 24 inches wide, and 6 inches thick. The differential gear will not, of course, be required, if the nature of the material operated upon is not very variable.

Circular Saw Benches.

There should be at least two of these machines in a saw mill, one with sliding top for long lengths, and a jobbing bench for small work. The larger one may be fixed to stone or timber foundation, as preferred; the price being reduced in the latter case.

Steam Power.

In deciding upon the steam power required for saw mills, there may be an advantage in having the vertical saw frame (generally requiring most power) worked by a *separate engine*, as quoted for in the first list of these machines. In this case, any stoppage for repairs to the engine working the rest of the machinery would not interfere with the main machine; and on the other hand, repairs to the vertical saw frame engine could be made during the time all the other machines were working. One boiler would answer for the two engines, as any repairs to this can usually be done in a night or so. The power required, if all the above machines are worked by a single engine, would be from 30 to 50-horse power, according to whether the smallest or largest set of machines was adopted. If the vertical frame be worked by a separate engine, from 6 to 12-horse power may be deducted from the above; and if no deal frame be used, another 6-horse power may be deducted, leaving from 20 to 40-horse power. The boiler should be of ample size, as the variable nature of the work is apt to cause irregularity in the motive-power, unless there is plenty of steam room in the boiler.

The best arrangement of buildings for saw mills is, perhaps, that of several long narrow sheds (the number being proportioned to the number of machines), placed side by side, both ends being open. For the machines

above enumerated, five sheds would be required for engine and boiler, vertical frame, deal frame, planing machine, and circular saws.

At one end of the range of buildings, it is very convenient to lay down light rails and a travelling crane to bring up the logs to the mill. At the opposite end, rails are also convenient for a timber truck, to be used in removing the deals from one shed to the other, or for storage. Indeed, rails from the end of each principal machine, and completely through the saw shed and yard, terminating in turn-tables, for the easy transit of the timber, is an arrangement which has been found to save valuable time otherwise necessarily spent in lifting the deals about by hand.

Instead of turn-tables, a carriage may be arranged with a double set of wheels, so as to travel in directions at right angles to each other. Where many turn-tables would otherwise be required, this plan has many advantages.

Corrugated iron sheds may be, with many important advantages, employed for saw mills. Being fire-proof, they are, of course, far safer than wooden buildings, and are very rapidly erected. The roofs may be supported on iron columns, the ends and outer sheds only being closed in with corrugated sheets, and the engine and boiler-house separated by an iron partition from the other part of the building.

The best arrangement of shafting for driving the machinery is to carry it under the floor level, the belts being brought up to each machine. The shafting bearings should be all protected as well as possible from the saw-dust.

CHAP. XII.—ICE-MAKING MACHINES.

The manufacture of ice in tropical climates is the most important and successful operation to which the refrigerating machine has been applied; the great expense and loss attending the supply of natural ice is thus avoided, and a supply of ice is formed daily on the spot, as required for use.

The machine is constructed on the principle of the evaporation of a volatile liquid in a vaccum at a low temperature, the caloric contained in such liquid passing off in the vapour; the latter is afterwards condensed under pressure, and the liquid used again to undergo the same treatment. The volatile liquid is contained in a vessel called the refrigerator, connected with which is a double-acting air pump. This pump withdraws at each stroke a quantity of vapour from the liquid, and forces it into another vessel called the condenser, where it is condensed, and whence it is returned to the refrigerator to be again used. The process thus continues without any appreciable waste of material. Where the vapour is raised an intense cold is produced in proportion to the rapidity of the evaporation. The ice is formed in solid blocks, and is more or less transparent in proportion to the relative quantity acted upon at the same time.

For the cooling of hospitals and other buildings this machine is very valuable, as being capable of reducing the temperature and retaining it at a low point. It has been proved by experiment that this is practicable, the temperature of a chamber having been reduced to within six degrees of freezing point, while the temperature outside ranged at 90° Fahrenheit.

The cooling of wort in breweries and distilleries is a process to which these machines—by reason of their immense refrigerating power, and their capabilities to remove the caloric and lower the temperature of the wort to any desired degree—are admirably adapted.

The cost of producing ice by these machines in this country has been found not to exceed 10s. per ton, including all expenses, labour, steam power, material, &c.

These machines are adapted to be worked by a steam engine, which can be supplied with each machine, or any existing engine might be employed for the purpose.

The machines can be made of any dimensions required. The prices of the ordinary sizes are as follows:—

No. of Machine.	Quantity of Ice produced in 24 hours.	Price with Steam Power, complete.	Price without Steam Power.
1	½ ton.	£	£
2	1 „	£	£
3	2 „	£	£
4	4 „	£	£

CHAP. XIII.—PUMPS AND PUMPING MACHINERY.

The various designs of pumps and pumping machinery are so numerous, and their adaptation for different purposes so general, that it would be almost impossible to describe them separately. It is, therefore, only necessary to submit particulars of a few designs of pumps and pumping machinery, which G. B. & Co. from their extensive experience can recommend to the notice of purchasers.

Centrifugal Pumps.

(For steam or other power.)

These pumps are now in very general use for all purposes, and arranged to be worked by hand, animal, steam, or wind power. The following is a summary of their advantages :—

1. They can be erected with ease and celerity.
2. They work with an easy rotary motion, without valves, eccentrics, or other contrivances, which consume power in friction.
3. They will discharge a quantity of water greater than any other pump, 70 per cent. being taken as the average. Under favourable circumstances a much greater result has been attained.
4. They are economical in use, simple in construction, and of very great durability.

5. Their cost, measured by the quantity of water discharged, is greatly below that of all other pumps in use.

6. They are not affected by sand, mud, grit, or other foreign matter in the water, which so rapidly destroy all other pumps.

7. They will admit, in the large sizes, the passage of *solid bodies* three inches in diameter; and the smaller sizes in proportion, without injury.

8. They will pump hot or cold liquids equally well.

9. They require a very light and inexpensive foundation, having no vibration in their working, as reciprocating pumps.

The following table gives the capabilities of the most useful sizes as well as their prices, which are inclusive of piping, and delivered in London :—

Sizes of Pumps.	Maximum discharge per minute.	For Steam, Cattle, or Wind Power.		
		Lifts under 30 feet, for Drainage, Irrigation, Dry Docks, Coffer Dams, &c.	Lifts from 30 to 70 feet, for Builders, Contractors, and Manufactories generally.	Lifts above 70 feet, for Fire Engines, Deep Mines, Coal Pits, &c.
1	25	£	£	£
2	70	£	£	£
3	125	£	£	£
4	150	£	£	£
5	300	£	£	£
6	500	£	£	£
7	1,000	£	£	£
8	1,400	£	£	£
9	3,000	£	£	£
10	5,300	£	£	£
11	12,000	£	£	£
12	21,000	£	£	£

The power required to work any of the above pumps may be readily determined by considering that it takes on the average one horse power to raise 100 gallons of water 20 feet high; the largest pumps requiring, however, less power than this by about 20 per cent., and the medium sized pumps proportionally less.

The quantity of water raised may be increased by increasing the velocity of the pumps above that contemplated in the above table, or the same quantity may be raised to a higher level; but the quantities given are the maximum quantities which can be raised without waste of driving power.

Note.—When the pump is placed *above* the fluid to be raised, a foot valve is required.

FIXED STEAM PUMPING ENGINES.

The extreme simplicity of steam pumping engines have rendered their application generally serviceable, supplying as they do an important want, so frequently experienced in engineering, agricultural, and manufacturing works, of a compact arrangement of motive power for lifting and forcing water to any required distance or height.

They are supplied with and without boilers, and mounted on wheels when required to be portable.

Patent Steam Pumps,

For feeding stationary, marine, and locomotive boilers, and as a water lift to supply tanks, &c.

Prices, delivered in London.

Size of Pump.	Horse power.	Purpose for which constructed.	Quantity of water thrown.	Height	Time.	Price of Steam Pump only.
			gallons.	feet.	hours.	
1A		To feed high and low pressure boilers	3,500	100	10	£
1		Ditto	7,000	100	10	£
1A		As a water lift, to supply tanks, &c.	12,000	50	10	£
2		To feed high and low pressure boilers	14,000	100	10	£
2A		As a water lift, to supply tanks, &c.	20,000	50	10	£
3		To feed high and low pressure boilers	22,000	100	10	£
3A		As a water lift, to supply tanks, &c.	35,000	50	10	£
5		To feed high and low pressure boilers	50,000	100	10	£
5A		As a water lift, to supply tanks, &c.	75,000	50	10	£
7		To feed high and low pressure boilers	70,000	100	10	£
7A		As a water lift, to supply tanks, &c.	100,000	50	10	£

N.B.—The quantities and heights given are when high pressure steam is used.

The boilers are tubular, with internal fire-place, and are independent of all brickwork setting.

Prices of steam pumps and boilers complete, mounted on wheels, about per cent. extra.

Portable Steam Pumping Engines,

Designed especially for irrigation purposes, consisting of a portable high pressure boiler and steam engine, mounted on wheels, working a double acting pump.

The engine is fitted with a very simple adjustable expansion valve for the saving of fuel, and a boiler fitted with mountings in the usual manner.

A 10 horse power, capable of lifting 38,000 imperial gallons of water per hour to a total height of 40 feet, and provided with the necessary pipes for drawing and forcing from 32 feet below to a height of 39 feet above the level of the water, also the requisite tools and materials for putting together abroad. Price, delivered in London...£

A 5 horse power ditto, same as above, capable of lifting 16,500 gallons per hour a total height of 40 feet, and furnished with piping, &c., as above .....£

N.B.—The class of pump above described will be found more certain in its action when drawing water from a depth than the centrifugal pump.

Portable Centrifugal Steam Pumping Engines,

With pumps attached to end of boiler.

These engines are light, simple, powerful, and very effective for purposes of drainage or irrigation, emptying coffer dams, canals, reservoirs, dry docks, &c., where the water is not required to be drawn from a great depth.

They will, however, *force* the water to almost any height. With a small amount of power they discharge an immense body of water, and are moderate in price.

When not required for pumping, the engine may be easily disconnected from the pump (by simply taking off the belt) and applied to other work, such as sawing, thrashing, grinding, &c.

The boilers are tubular, and fitted with fuel-saving apparatus.

Price delivered in London.

4 horse power, fitted with a centrifugal pump capable of raising 150 imperial gallons of water per minute about 60 feet high .....£

5 ditto, ditto 300 gallons about 40 feet high .....£

6 ditto, ditto 500 „ 27 „ .....£

10 ditto, ditto 1,400 „ 15 „ .....£

14 ditto, ditto 3,000 „ 10 „ .....£

Larger sizes made to order.

N.B.—A foot valve, to go in the end of suction pipe, is supplied with these pumps, but no pipes to or from the pump are included in these quotations.

For purposes such as pumping out coffer dams, &c., where the pump requires to be placed low down, where it may be found inconvenient or perhaps impossible to bring the engine close to it, the engine and pump may be supplied separate from each other, or the pump can be detached from the end of the boiler and placed at any practicable distance.

Wind Power Pumping Machinery,

Fitted with centrifugal or common pumps, supplied to order.

Floating Fire Engines, with Centrifugal Pumps.

These valuable machines are now to be found in almost every harbour and dock. They are supplied with high pressure expansive condensing steam engine, with surface condensers, tubular boilers, screw propeller, &c., and combine the most recent improvements in arrangement and construction.

The pumps are capable of discharging from 8 to 12 tons of water per minute, and throwing the same in a continuous stream to a height of, say 100 to 150 feet. With one of these floating fire engines every city, harbour, and shipping port should be supplied, as with such a powerful engine at hand the most terrific fires could be easily and quickly overcome. Six or eight large hose pipes can be worked at one time, and may be directed to the same or different points.

The pumps, when not required for use, may be thrown out of gear, and the screw propeller put in action, making the floating fire engine a powerful and highly efficient steam tug.

Estimates and plans will be furnished on application.

Hand Pumping Engine.

This hand engine has been selected by the Great Indian Peninsular and other Railway Companies, and is now extensively used as a most effective machine for pumping water from wells, for the supply of locomotives, railway stations, and other buildings where a large quantity of water is required. It is capable of raising about 20 gallons per minute from a depth of 30 feet, and will also be found very useful in *forcing* the water to considerable distances when required.

Price delivered in London.

A 3½ in. *double* barrel brass pump, 5 ft. fly wheel, brass couplings, handles, and improved kite motion, complete, mounted on a strong cast iron frame, adapted to be placed over the mouth of a well, ready to be attached to piping; also, a copper air vessel, each .....£

The following smaller size is also made:—

With a *single* 3½ in. brass pump, capable of raising about 10 gallons per minute, and copper air vessel, &c., complete. Price, as above .....£

Foot valves for the above, necessary for depths above 20 feet, each .....£

Hand Pumps.

These pumps are constructed for various purposes. The valves are made of material suited for pumping hot or cold water. G. B. & Co. have furnished a great number of these pumps to the colonies for filling tanks, both for household purposes, as well as for manufactories, feeding steam boilers, &c.

Price delivered in London.

A 2½ in. gun metal lift and force pump for cold water, with leather valves of best quality, wrought iron slings and handle, brass union couplings, brass foot valve for lifting water from a considerable depth, fitted with leather valve, the whole secured to a good strong hardwood plank; including also about 40 feet of wrought iron suction piping and 70 feet of delivery piping, with sockets, elbows, &c. .....£

If fitted with India rubber valves instead of leather, and suited for either hot or cold water.....£

If fitted with gun metal vales and seats, suitable for pumping hot or cold water.....£

A small gun metal cock is fitted into the rising main chamber of these pumps, so that water can be drawn off into a bucket when required.

Cattle Pumping Engine,

Consisting of a strong circular cast iron frame, bolted to mouth of well, and fitted with swivel yoke for one animal, bevel wheel and pinion, double throw crank slings, and guides, complete.

Also, a fullway 4 inch *double* barrelled deep well pump, with valves attached to moveable doors, recommended for the great facility with which the valves can be repaired or cleansed without removing the pumps from the well.

Price, complete, ready to be attached to the piping, delivered in London .....£

Steam Pumping Engine,

With cast iron tank, complete.

This powerful apparatus consists of a high pressure steam pumping engine and boiler complete, capable of pumping gallons of water per hour. The engine is placed over the well, and connected, by means of suitable piping, with a tank on top of engine house, capable of holding gallons. The whole fitted with piping and valves complete, within walls of engine house, ready to be erected and set to work.

Price delivered in London, packed for shipment .....£

Water Rams.

These machines are suitable for raising water for manufacturing or domestic purposes, as also for irrigating land above the level of the stream.

The water ram, although it often figures in books on hydraulics, is less used than it ought to be. It is generally regarded as a curious old-fashioned device, and thought no more about; but for cheapness, simplicity, and useful effect combined, few machines are superior.

There are many localities where the water ram may be used with great benefit, as it steadily and constantly performs its work, with very little care, except to see that the water is strained through a grating, to keep back extraneous substances, and that the apparatus is protected or emptied during a hard frost.

In practice, about 50 to 70 per cent. of useful effect may be calculated upon, and good results are obtained when the ram raises water *seven* times the height of the fall. The lowest available fall is about 2 feet, and the highest, 35 to 40 feet. The quantity of water they raise varies with the size of the ram and height of the lift, from half a gallon to six gallons per minute. The greatest height to which water has been raised by these machines is 330 feet.

To enable correct estimates of the size, capability, and cost of these machines to be made, Messrs. G. B. & Co. require to know:—

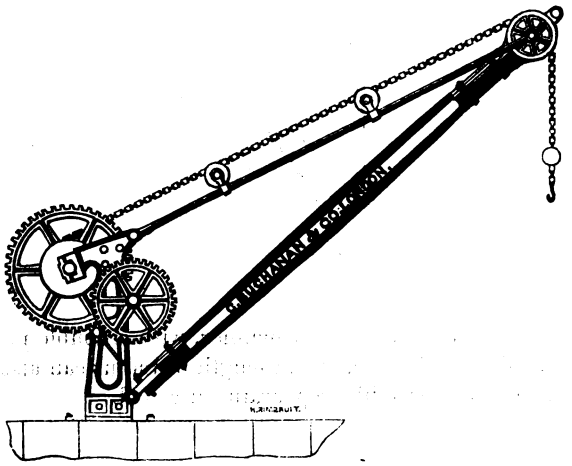
1st—The number of feet fall to be obtained at the spring or brook to work the ram.

2nd—The perpendicular height from the lower part of the fall to the point where the water must be delivered.

3rd—The horizontal distance from the place of supply to the place where the water is wanted; and, if the spring or stream be small, it is desirable to ascertain how many gallons it flows per minute.

CHAP. XIV.—CRANES AND WINCHES.

ORDINARY FIXED CRANES.



The above sketch represents one of G. B. & Co.'s improved fixed cranes, suitable for hoisting goods ranging in weight from one to thirteen tons. They are suitable for dockyards, railways, wharves, and almost every situation. The materials and workmanship are of the very best quality, and each crane is guaranteed to lift with safety the weight noted.

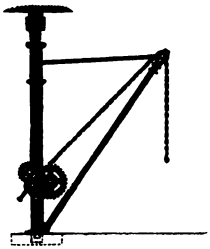
PRICES.

				Delivered in London.
To lift 20 cwt.;	radius, 9 feet;	height, 10½ feet;		£
,, 30 ,,	9½ ,,	10½ ,,		£
,, 50 ,,	13 ,,	14 ,,		£
,, 4 tons	,,	,,		£
,, 6 ,,	16 ,,	16 ,,		£
,, 8 ,,	17 ,,	17 ,,		£
,, 10 ,,	18½ ,,	18½ ,,		£
,, 13 ,,	18½ ,,	18½ ,,		£

For larger sizes, up to 100 tons, estimates may be had on application. The height and radius may be varied from the above to suit the require-

ments of a purchaser. A WEIGHING APPARATUS can also be attached, so that they would lift and at the same time weigh with accuracy. The additional cost of the same would be about 50 per cent.

Pillar or Warehouse Cranes.



These cranes are fitted in the best manner, with a double purchase, and can be had of any size. The height and length of radius can also be altered, as mentioned above, and a weighing apparatus attached.

PRICES.

Delivered in London.

To lift	20	cwt. ;	height,	6	feet ;	radius, 4 feet,	£
,,	30	,,		6½	,,	4½ ,,	£
,,	2	tons ,,		7	,,	5 ,,	£
,,	3	,,		7½	,,	5½ ,,	£
,,	5	,,		8	,,	5½ ,,	£
,,	8	,,		9	,,	6 ,,	£
,,	10	,,		10	,,	7 ,,	£

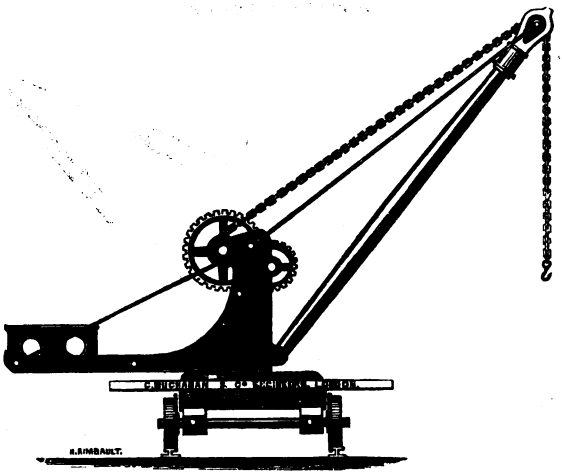
The points on which the crane works at top and bottom are made of steel, carefully turned and fitted, and each crane is guaranteed as above.

10 cwt. Warehouse Crane, with jigger, £

PORTABLE CRANES.

Useful Portable Balance Crane,

FOR GENERAL PURPOSES.



These cranes will be found very useful in warehouses, and on wharves, railways, &c., where it is not convenient to have a stationary crane erected. They are constructed to raise weights varying from one to ten tons a height of 12 or 13 feet, and a radius of 9 or 10 feet. Persons having heavy goods to load or unload in or out of carts, will save the cost of one of these cranes in a few months, as well as insure their men against accident. Two men can raise one ton with one of them.

They are made either to run in rails or on the ground, as may be desired. The balance weight can be easily adjusted to suit the load.

PRICES.

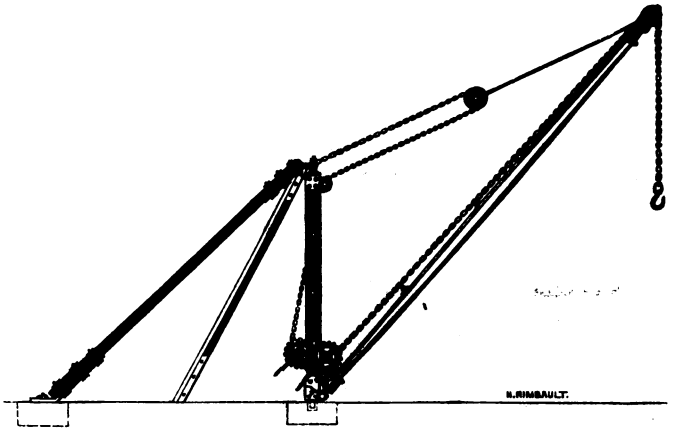
For cranes of *the first quality*, mounted on trucks, complete, delivered in London.

No. 1. To lift 20 cwt....£	No. 4. To lift 5 tons...£
„ 2. „ 30 „ ...£	„ 5. „ 10 „ ...£
„ 3. „ 50 „ ...£	

Intermediate sizes in proportion.

N.B.—Strong rough cranes are supplied for contractors and builders' use, at about per cent. cheaper than the above.

Derrick Cranes.



These cranes are very suitable for *stone quarries*, and other places where the foundation is of a temporary nature and where a great sweep of jib is required. They are also well suited for the construction of *breakwaters*, *&c.*, being easily moved about and fixed again as the work progresses.

The cranes of this description, supplied by G. B. & Co., are fitted with IMPROVED SAFETY GEAR FOR LOWERING HEAVY WEIGHTS, and are, in other respects, carefully adapted to the work they have to perform.

Prices.

Fitted with chains and stays complete, delivered in London.

No. 1.	To lift	20	cwt.;	sweep of jib	feet	... £
„ 2.	„	30	„	„	„	... £
„ 3.	„	50	„	„	„	... £
„ 4.	„	4	tons	„	„	... £
„ 5.	„	6	„	„	„	... £
„ 6.	„	8	„	„	„	... £
„ 7.	„	10	„	„	„	... £

Travelling Cranes,

Made to span any width, and to carry any weight.

The price of a travelling crane, suited to carry six tons, and to span 24 ft., exclusive of side rails and supporting beams, delivered in London, is £

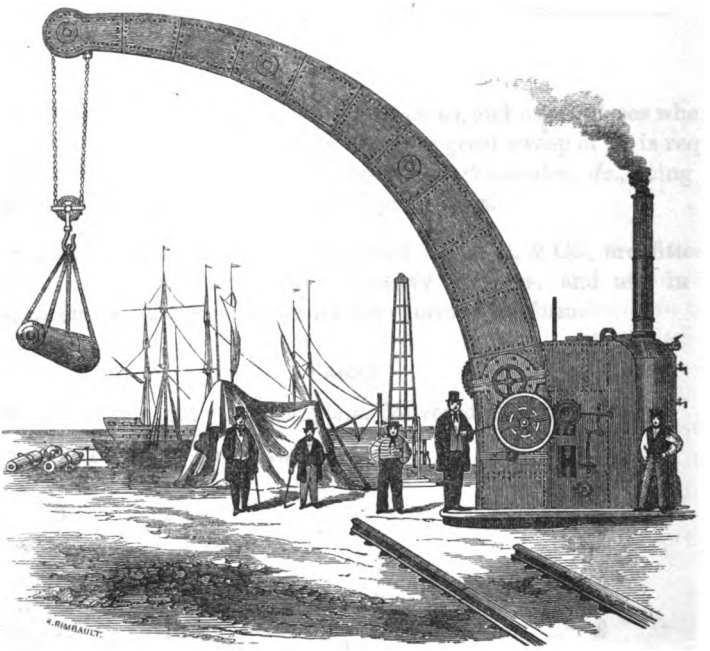
Particulars of other sizes forwarded on application.

WROUGHT-IRON TUBULAR CRANES.

The advantages peculiar to this construction of crane are, its great security, and the facility with which bulky and heavy bodies can be raised TO THE VERY TOP OF THE JIB without the least risk of failure.

For loading and unloading marine boilers, therefore, and large bulky articles of merchandise, masting ships, &c., they are, no doubt, superior to all others.

G. B. & Co. supply them of all descriptions, viz., *fixed* or *portable*, and to be worked either by hand or steam. The following is an illustration of a 60-ton crane of this description, worked by steam power.



The following are the prices of the different varieties, delivered in London.

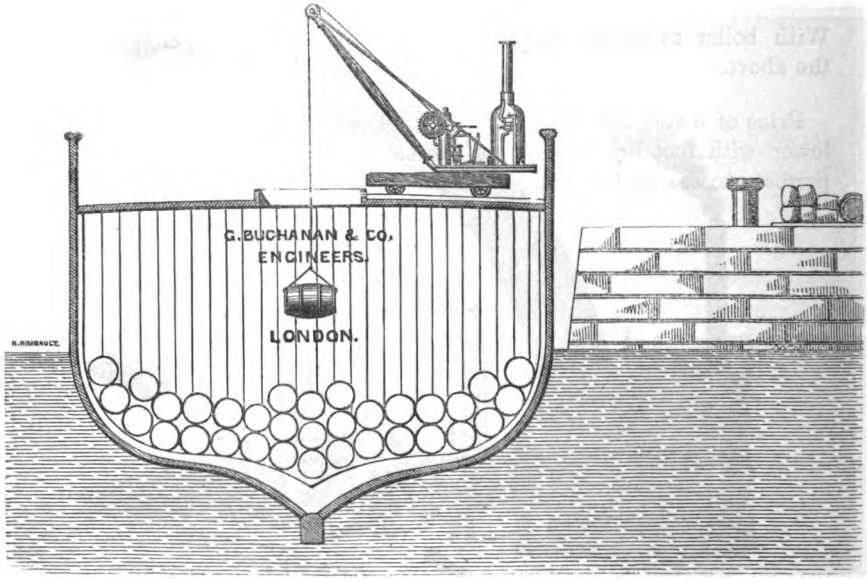
To lift in Tons.	Height of Lift, in Feet.	Radius of circle swept by Jib, in Feet.	Fixed Cranes.		Portable Cranes.	
			For Hand Power.	For Steam Power, with Engine and Boiler, complete.	For Hand Power.	For Steam Power, with Engine and Boiler, complete.
5	...	...	£	£	£	£
10	26	25	£	£	£	£
20	...	...	£	£	£	£
40	...	...	£	£	£	£
60	60	53	£	£	£	£

Intermediate sizes in proportion. The height of lift, or sweep of jib, may be varied as desired.

STEAM CRANES.

These most useful labour-saving machines are made both fixed and portable, to lift any weight, and are so easily managed that one man can lower, lift, and stow any weight by merely raising or depressing one or two handles. They combine within themselves a perfect steam engine, boiler, and hoisting apparatus, and are now rapidly taking the place of hand cranes in all situations. For quick despatch in loading and unloading ships, railway trucks, &c., they are especially valuable.

The following illustration shows one placed on the deck of a vessel unloading her cargo.



The engine and boiler swing completely round on the centre pillar, and counterbalance the load. The jib is adjustable, and the larger sizes hoist,

lower, and turn round in either direction, by steam power; the smaller sizes hoist and lower by steam, and turn by hand.

They may be worked as hand cranes when the steam is down.

Prices, delivered in London, as follows, viz. :—

Portable Steam Cranes,

On wrought-iron carriage and wheels, with link, reversing motion, foot break, &c., all under the easy control of one man.

4-horse power,	to hoist	(with return chain and block)	30 cwt.	...£
5	„	„	45 „	...£
7	„	„	60 „	...£
8	„	„	5 tons	..£

Larger sizes in proportion.

Fixed Steam Cranes,

With boiler to swing completely round, about per cent. less than the above.

Price of a steam crane to lift 25 or 30 cwt., to swing round by hand and lower with foot break, used in stores for loading sugar hogsheads with perfect success, and a saving of 75 per cent., delivered in London, £

HYDRAULIC CRANES.

Cranes worked by water-power are supplied by G. B. & Co., on the plan originally proposed by Sir William Armstrong. They are characterized by remarkable steadiness and precision of movement. By means of regulating handles (or chains passing through several stories of warehouses), their motions both in lifting and lowering, as well as in turning, are controlled with perfect ease and accuracy, and the speed with which they may be worked has no other limit than that imposed by the size of the supply pipe.

Nearly 2000 of these valuable machines are now to be found at work in various parts of the country, at wharves, docks, railway stations, raising and lifting waggons, in the shipment of coals, opening and closing swing bridges and dock gates, &c. They admit of very extensive and useful application in mercantile docks, not only to cranes for lifting heavy weights, but also for "whipping" light goods from ships, and for opening and shutting lock gates, swing bridges, and sluices.

The facility with which water may be conveyed to the place where the power is wanted, the ease with which it may be managed, its perfect safety, and its constant readiness for action, render it eminently suitable for these purposes.

By an admirable but very simple contrivance the working of hydraulic machinery is now rendered entirely independent of the ordinary water supply of towns, &c. This is accomplished by part of the apparatus called an *accumulator*, in which the water is pumped by steam power under a pressure usually equal to 1,500 feet of head; thus reducing the size of both pipes and cylinders. Besides this, the duty of the engine is perfectly equalised, notwithstanding the quantity of power to be supplied is subject to great and sudden fluctuations, especially where many machines are worked from a common source.

The most approved engines for charging the accumulators are those consisting of two high-pressure cylinders fixed horizontally with double-acting pumps.

Any amount of motion in the chains of these machines is obtained by a suitable arrangement of sheaves in the inverted order of blocks and pulleys.

In addition to the many uses of these machines above named may be mentioned the working of vertical hoists, at the landing stations of steam ferries, in cases where a railway traffic is required to be passed over a river or estuary not easily crossed by a bridge. In an arrangement of this kind a train of 12 coal waggons, weighing collectively 133 tons, can be transferred from the deck of a steamer to a railway, a height of about 20 feet, in 12 minutes. Each hoist lifts two waggons at a time, and raises its load in 10 or 12 seconds. The hoists being arranged so as always to accommodate themselves to the level of the boat, and always to stop at the exact level of the railway.

Estimates for any machinery of the class here described will be furnished by G. B. & Co., upon the special requirements being given them. It is necessary, in ordering hydraulic crane machinery, to define the lift and range of the cranes required, and the greatest weight to be raised; as also, if more than one, the distances between them, and from the nearest crane to the accumulator. Too many particulars cannot be given in order to ensure correct estimates being furnished.

CRAB WINCHES,

Single and double purchase, of superior construction, with strong cast-iron sides.

PRICES.

G. B. & Co. also supply a very excellent crab winch for export, made with *wrought-iron sides*, and therefore not liable to get broken in transit. Large numbers have been sent to India, and highly approved of.

Price of the same, delivered in London.

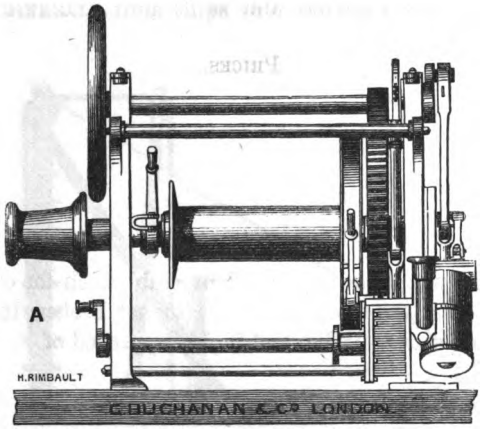
Single purchase, £
Double ditto, £

Ships' Winches

At prices proportionate to the above.

STEAM WINCHES.

For discharging ships' cargoes, and also for working the bilge pumps.



As will be observed from the illustration, the engine and winch are all combined on one strong iron frame, which is bolted to the deck of the ship, the motion being communicated to the bilge pump by the crank A.

G. B. & Co.'s winches possess this great improvement, that the power is communicated by means of FRICTION PULLEYS, so that the engine can be disconnected at once, WHILE GOING, and the load lowered without loss of time.

PRICES.

	Delivered in London.
2-horse power, to lift 15 cwt. at a quick speed	£
Ditto, with steam boiler and connections, complete ...	£
3-horse power, to lift 2½ to 3 tons at a slow speed	£
Ditto, with steam boiler and connections, complete ...	£

N.B.—A small feed pump, to feed the boiler, is attached to each winch.

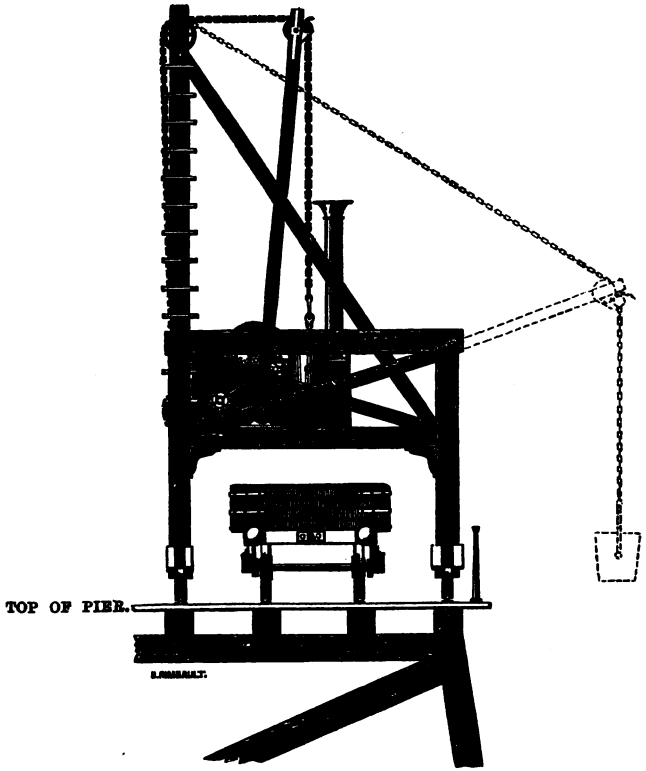
Lifting Blocks,

Of the best quality, suited to the crab winches and other hoisting machinery.

PRICES.

Portable Steam Hoisting Apparatus for Discharging Ships.

This most valuable machine is specially adapted for discharging IRON, COAL, and other MINERALS, from ships into railway trucks, or any other kind of waggon.



As will be observed from the illustration, the apparatus itself travels on rails, and can be moved to any part of the pier; the trucks being passed under it to be filled. When at work, the jib is lowered to over the centre of

the vessel's hatch, and the goods rapidly drawn up until the ball on the chain comes in contact with the jib, when jib, goods, and all are lifted to over the centre of the truck, and the goods emptied into it. Every operation is performed entirely by the steam engine under the control of ONE MAN. By the engine being placed on the platform above the trucks it is completely out of harm's way, and not liable to be interfered with by any person but the engineer.

Price of the iron and wood work, complete, of an apparatus suited to discharge 400 tons of Minerals per day of ten hours; delivered in London, £ Rails and other pier fixings, extra.

CHAP. XVII.—HEAVING-UP SLIPS.

These "Heaving-up Slips" are considered most valuable for the purpose intended—viz., to draw up ships out of the water, for repair or examination. Their simplicity of construction, easy erection, and inexpensive maintenance render them specially suitable for Colonial use. Their peculiar design enables them to be erected not only in harbours, but also on any beach on the coast.

The Machinery is specially designed on the most approved plan, and made of the very best materials.

G. B. & Co. supply these slips fitted complete, to take in vessels of from 300 to 3000 tons.

Probably the most useful size of slip to send out abroad is one capable of taking up with ease vessels of 1200 tons, and on occasion, still larger ones.

The usual length of ways for such a slip is 600 feet, with five ways (ratchets on the centre one), and cradle 200 feet long, made to disconnect in the middle, so that a small vessel may be left on the upper half, if desired, and the lower half let down to bring up another vessel. It takes a 25-horse power engine to work a slip of this size.

The slips manufactured by G. B. & Co. are fitted with gearing which is considered to be, on the whole, better suited for the Colonies than a hydraulic ram, as, if a wheel breaks, it can be repaired on the spot; whereas, if the hydraulic cylinder splits, the whole affair is at a stand, until a new one is received from England.

Prices, delivered in London, packed for shipment.

One 1200-ton slip, complete, with cradle, 25-horse power steam engine and boiler ... ... £

Ditto, without the wood work of cradle, which can be sometimes advantageously supplied abroad ... ... £

800-ton slip, having five or three ways, 450 feet in length, and 150 feet of cradle, with steam engine, boiler, &c., complete ... ... £

The same, exclusive of wood work ... ... £

300-ton slip, having three ways, 300 feet long, and 90 to 100 feet of cradle, with steam engine, boiler, &c., complete ... ... £

The same, exclusive of wood work ... ... £

N.B.—Estimates for all other sizes furnished on application.

Estimates for hydraulic slips furnished, if required.

CHAP. XX.—ELECTRIC TELEGRAPHS.

For Land and Submarine Purposes.

The value of electric telegraph communication may now be considered to be universally admitted, not only in combination with railways, but carried over extensive tracts of country from town to town for commercial purposes. Their simplicity of erection, and the almost entire absence of expense in maintenance, recommend their adoption in every country.

The different classes of construction are very numerous, and adapted for all requirements.

Electric Telegraph Apparatus for Land Purposes.

G. B. & Co. are contractors for the supply of every description of telegraph apparatus. They have had considerable experience in furnishing it for various lines erected in several parts of the world. The instruments, insulators, and other important parts, are carefully tested by an Electrician previous to shipment. Every article is of the best description, and guaranteed to be perfectly efficient.

Battery instruments are recommended in preference to *magnetic* ones, as being more easily worked and at double the speed.

Materials for Single Wire Line, per Mile.

(Exclusive of poles.)

The following price includes No. 8 best galvanized iron wire, patent white porcelain insulators, fitted with galvanized iron pins, patent malleable iron brackets, with screws for attaching to wooden or iron poles.

Price of materials, as above specified, for *one mile* .....£

Single needle instrument of the best make, with four patent sulphate batteries, sufficient to signal 50 miles, and all necessary fittings.

Price of the above, which are required for *each station*...£

The following *spare stores* are usually supplied for the above single wire line *per station*, consisting of the following articles:—

Twelve patent porcelain insulators, with brackets complete, half a needle instrument (one spare instrument being sufficient for two stations), one battery, two needles and axles, one box with one spare coil, one instrument handle, ten porous battery cells, twenty pairs of battery plates, three porcelain chambers, and 28 lbs. of sulphate of copper.

Price of the above set of stores, required for *each station*, £

Materials for Double Wire Line, per Mile.

(Exclusive of poles.)

The following price includes No. 8 best galvanized iron wire, patent white porcelain insulators, fitted with galvanized iron pins, patent malleable iron brackets, with screws for attaching to wooden or iron poles.

Price of materials, as above specified, for *one mile* .....£

Double needle instrument of the best make, with four patent sulphate batteries, sufficient to signal 50 miles, and all necessary fittings.

Price of the above, which are required for *each station*...£

The following *spare stores* are usually supplied for the above double wire line *per station*, consisting of the following articles:—

Twenty-four porcelain insulators, with brackets complete, half an instrument (one spare instrument being sufficient for two stations), one battery, three needles and axles, one box with two spare coils, two instrument handles, ten porous battery cells, three porcelain chambers, twenty pairs of battery plates, and 28 lbs. of sulphate of copper.

Price of the above set of stores, required for *each station*, £

The quality of the above materials and stores, both for the single and double lines, is such that they may safely be used for any length up to 400 *miles.*

For every additional 50 *miles above the first* 50, *up to* 400 *miles, two batteries will be required.*

Price of each battery .....£

Insulators.

These may be classified as *stretching post insulators* and *intermediate post insulators*. The former are placed about every *sixth post*, and arranged for the purpose of tightening the telegraph wire; the latter are intended for supporting the wire at the intermediate points.

These insulators are prepared on the most approved plan, with cast iron bell, insulating porcelain cup, and wrought iron stalk, all firmly cemented together, with screw, &c., complete, ready for fixing.

	Price delivered in London.
Stretching post insulators, complete ..... per doz.	£
Intermediate post insulators, complete ..... „	£

Telegraph Poles.

The number of poles required per mile is 26. These poles are constructed of wood or iron, as may be decided upon. When the former material is used, it will generally be found at or near the spot of erection, and obtained at a very moderate expense. In places where timber is scarce iron poles are supplied, which, from their peculiar construction, are extremely light and portable, and can be erected without any trouble.

Price of each iron pole, complete .....£

Price of 26 poles, for one mile .....£

Telegraph Wire.

Best selected telegraph wire, galvanized, No. 8, of medium thickness, *with twisted joints.*

Price per ton .....£

Submarine Telegraph Cables.

These are constructed in the most approved manner, and prepared by a peculiar process to withstand the action of water, the cable remaining perfect for a number of years. The tensile strength and low specific gravity of this kind of cable present most favourable claims for its general introduction, both as regards first laying down and subsequent maintenance, as well as for easy transport.

These cables are made to any required number of strands, and specially prepared for peculiar localities. They are also suited for underground, military, and mining operations.

Estimates will be furnished by G. B. & Co. for any line required, together with instruments and plant complete, and full instructions for working the same.

CHAP. XXI.—WATER WORKS.

THE advantages of the application of steam power to the water supply of towns, is now so universally recognised, as also the necessity, in a sanitary point of view, of that supply being constant, regular, and abundant, that any remarks on these heads are superfluous. At the same time there cannot be a doubt, that in numerous cases the views that are entertained of the difficulty and great expense of erecting water works for the supply of villages or small towns are such as to deter the residents of such places from attempting their establishment. The object of the following remarks is to show that the difficulty and expense in the erection of water works are not great, and that the prevailing notion of very extensive works being necessary, in order that the expenses should be proportionately diminished, is entirely opposed to the practical experience of the present day, which confirms the view that moderate-sized works are on all accounts to be preferred to those involving a very large outlay, and in which the *surplus* power must be very much higher in proportion to the average work to be performed. In confirmation of this view, it will only be necessary to adduce one example. For the supply of the town of Liverpool, containing upwards of 500,000 inhabitants, requiring, according to the usual allowance of 20 gallons of water per head, upwards of 11,000,000 of gallons per day, the most recent recommendation is that each pumping station should be erected to supply *one million* gallons only, equivalent to the wants of 50,000 persons, it being considered on the whole far better and cheaper to divide the town out into several districts, than to erect one or more large and expensive works for the supply of the whole.

The distribution of several comparatively small works, even where very large quantities of water are required, is recommended mainly on two grounds: first, the less necessity, in the case of several works being established, of a large surplus power at each station; and, secondly, that the *whole* of the water need not be pumped to the highest reservoir, but that the different levels of a town may be supplied from the most suitable stations.

This example is given simply to show that under the most favourable circumstances large works are not desirable, and that no appreciable loss arises

from works of the most moderate proportions being established, which may afterwards be added to, as the population of any town or district increases.

An attempt will here be made to furnish those seeking information on this subject with the means of forming an approximate estimate of the cost of establishing water works of sizes suited to several classes of towns. These estimates will be made under the following heads, as regards the machinery employed,—

1st. Pumping engines and boilers.
2nd. Pumps and valves.
3rd. Water mains.

Before proceeding to give estimates for the several portions of machinery required in the establishment of water works, it will be desirable to give the following data, upon which such estimates are based:—

1st. Each head of the population is assumed to require 20 *gallons* of water *per day of* 24 *hours*.

2nd. The water is assumed to be raised 100 feet of *perpendicular height*, the cost of pumping being *directly in proportion to the lift*.

There will be no difficulty in modifying these estimates for any other lift required; for example—if the lift be 50 feet, the cost of machines will be just half that given; and if the lift be 200 feet, it will be just double, and so in direct proportion.

3rd. When the cost of fuel is about 20s. per ton, it constitutes about two-thirds the total working cost of pumping water, or say 70 per cent., the wages usually amounting in this case to about 25 per cent., and the oil, tallow, &c., to about 5 per cent. of the entire cost.

4th. That the *rate* at which the water is raised, that is, whether a given quantity be required to be raised in 24 hours or in 12 hours, does not materially affect the current expenses of raising it; but, of course, the quicker the work is performed, the larger the outlay must be for engines, pumps, buildings, &c.

5th. The cost of the requisite machinery, buildings, &c., for raising a given quantity of water in 24 hours is about 50 per cent. less than it would be for raising the same quantity of water in 12 hours.

6th. The cost of building, taken at average London prices, is usually found to amount to about *one-half* of the total cost of pumping machinery, including engine, boilers, and pumps.

7th. The actual cost of raising 1,000,000 gallons of water 100 feet high is, in well-managed establishments, about 25s., coals being about 20s. per ton; but in ordinary cases, 35s. would be the safer estimate. This includes fuel, wages, oil and tallow, &c.; but no allowance for wear or tear of machinery or mains, or interest on capital.

8th. The consumption of oil and tallow for pumping engines has been

found to be at the rate of about ½ gallon of oil and about ¼ cwt. of tallow per annum for each horse-power to which the engine is worked.

9th. The depreciation, or cost of maintaining engines, pumping machinery, and buildings, may be taken at 2 per cent. per annum on their cost, and the depreciation of mains at about ¼ per cent. per annum.

10th. The duty of a cwt. of Welch coals, or the quantity of water it will raise *one foot high*, may be taken at an average of 70,000,000 lbs. When little or no expansion of steam takes place in the cylinders of the engines, this may fall to 50,000,000; but in extreme cases, where great expansion is used, it may reach 100,000,000 lbs.

11th. That this duty of 70 million lbs. raised one foot high is equal to the consumption of about 12 tons per annum for each horse-power of the engine, or at the rate of about 3 lbs. per indicated horse-power per hour, the quality of the coals being equal to the evaporation of *nine times* their weight of water.

We have now to inquire the cost of steam engines, boilers, and pumping apparatus required for raising given quantities of water a given height, and within a given time; but, before doing so, we give an outline specification of the engine and pumps generally employed in water works.

The Engine.

Engines for pumping water are usually beam engines, constructed on the single-acting principle, and are worked with high-pressure steam, which is afterwards condensed. The cylinders are fitted with steam jackets, or casings, covered with felt, and encased in wooden baggings, to prevent radiation of heat. The top and bottom of the cylinder are also covered in a similar manner. The steam and external valves are equilibrium valves, and of the double-beat description. There is also a steam-governor valve, as well as expansion valves. These engines are fitted with air pump and condenser, also with cold water pump and feed pump.

The Boilers.

The boilers are usually cylindrical, with internal flues. They are fitted with all the usual boiler and furnace mountings, and are capable of being safely worked up to between 45 and 60 lb. per square inch.

The Pumps.

These are constructed either to *lift* or *force* the water to the height required. Lift pumps are of two kinds: those with solid pistons, and those

with buckets or valves in the pistons. Whichever kind of pump is employed, the valve-fittings are for the most part the same, being of the double-beat kind, and admirably adapted for avoiding any shock to the machinery.

Stand-Pipe or Air-Vessel.

In connexion with the pumps of water-works engines, it has been usual until lately to erect what are called stand-pipes, for regulating the work upon the engines, and also for getting sufficient pressure in the mains to overcome the resistance of the water flowing through them; but these constructions, which are very expensive, liable to injury from frost, and moreover objectionable as necessitating the motion of the whole column of water at every stroke of the engine, have been almost entirely superseded by the use of *air-vessels*, placed at the commencement of the main pipe—this vessel being kept partly filled with water, but having above the water a sufficient quantity of air, the elasticity of which produces a perfect equalization of the work on the engine. These air-vessels have pumps in connexion with them, for keeping up the requisite amount of air above the water. A safety discharge pipe is also fitted in proximity to each air-vessel. This valve being loaded to a little more than the pressure required in the main.

Cast-Iron Mains.

All pipes for the distribution of water are of the ordinary spigot and faucet kind, those above 3 in. diameter being usually cast in 9 feet lengths, and those under 3 in. diameter in lengths of 6 feet. The size of water-mains must of course depend on the quantity of water intended to pass through them, the inclination at which they are laid, and the length of piping required between the pumping machinery and the place where the water is consumed. The bends in long lengths of piping should be as few as possible, and the curves as gentle as they can conveniently be made.

ESTIMATES.

Price of high-pressure condensing steam engine, of 10½ actual or indicated horse-power, with boiler and pumps complete, capable of raising 250,000 gallons of water, 100 feet high, in 24 hours, and adapted for the supply of a town containing 12,500 inhabitants .... £

Price of high-pressure condensing steam engine, of 21 horse-power, capable of raising 500,000 gallons of water, 100 feet high, in twenty-four hours, and adapted for the supply of a town containing 25,000 inhabitants ..... £

Price of high-pressure condensing steam engine, of 31½ horse-power, capable of raising 750,000 gallons of water, 100 feet high, in twenty-four hours, and adapted for the supply of a town containing 37,500 inhabitants .. .. £

Price of high-pressure condensing steam engine, of 42 horse-power, capable of raising 1,000,000 gallons of water, 100 feet high, in twenty-four hours, and adapted for the supply of a town containing 50,000 inhabitants . £

NOTE.—*In calculating the capacity of the pumps for raising the several quantities of water above given for different populations, one-third is added to the said quantities, to allow for leakage, &c., so that the pumps, if working without loss, would deliver this extra quantity.*

So also, in calculating the powers of the engines required for raising the several quantities of water, they are reckoned at double the actual work of lifting the water, so as to allow for friction of pumps and engines, and other contingencies, such as stoppages, for the power here given necessitates both day and night work.

The total cost of establishing pumping stations, for raising any given quantity of water per day, depends so much upon the peculiar circumstances of each case, that it is impossible to give more than a general idea of what it would amount to under average circumstances, and at average prices. The cost is usually divisible into the following items, which are calculated at average London prices, for a station capable of raising 1,000,000 gallons in twenty-four hours. These estimates must be taken simply as approximations.

They require verifying, for any special case, by the actual circumstances of such case, both as regards cost of labour and materials.

1st. Well sinking, say 100 ft., at £ per ft. ..... £
2nd. Machinery, 42-horse power engine, boilers, and pumps, including erection at £100 ..... £
3rd. Engine and boiler houses (about half the cost of machinery..... £
4th. Cast-iron mains (according to distance), say ..... £
5th. *Covered* service reservoir (from 1 to 3 days' supply), say 2 days' supply ..... £
6th. Filter beds, of about 2000 yards area, and capable of filtering 1,000,000 gallons in twenty-four hours ... £

Total approximate cost ..... £

NOTE.—*If the water supply be from a river, it is usually found desirable to construct "depositing" reservoirs by the side of the filter beds, and in which the worst part of the impurities of the water are collected before passing to the filters. In this case, of course, no well-sinking is required, the cost of which would have to be deducted and set against that of the depositing reservoirs. It is also sometimes desirable to construct small* uncovered *reservoirs by the side of the covered ones, which latter may then be made less. The water from the uncovered reservoirs answers for all purposes except domestic ones, such as flushing sewers, watering streets, &c. Of course, this method requires suitable arrangements to be made in the mains, or in regulating the supply to houses.*

To the above estimate must of course be added the price of the land.

In addition to the particulars already given, but upon which some of the items in the foregoing estimate have been based, the following approximate cost of certain work required in the establishment of water works may be found useful.

Well Sinking.

From an average of many shafts sunk in the neighbourhood of London, through the London clay and other tertiary beds, it has been found that shafts may be sunk to the depth of about 200 feet, at the rate of from £5 to £10 per foot vertical—this cost including the "stemming" and temporary pumping, if required. Also, that larger shafts, say 8 to 10 feet diameter, of equal area, may be sunk to from 200 to 300 feet depth, at from £21 to £27 per foot vertical. Further, that the cost of *boring and tubing* at the bottom of deep wells may be done at about £2 per foot vertical. Again, the cost of *driving headings*, say 5 feet high, and 3 feet 6 inches wide, where these are

found necessary to collect the water at the foot of a well, varies from £4 to £10 per yard forward, according to the nature of the soil, the latter price being for headings driven through sandstone rock.

Machinery.

The cost of steam engines, boilers, pumps, &c., may be roughly taken at about £100 per *actual horse-power* of the engine (each actual horse-power being equivalent to the raising of 33,000 lbs. 1 foot high per minute).

Buildings.

These may be roughly estimated, when substantially made, at about *one-half* the cost of the machinery.

Cast-Iron Mains.

The cost of mains of special sizes will be found under the head of "Cast-iron Pipes," chap. of this Catalogue. The proportionate cost of mains to the machinery of water works is very various, according to distance traversed, and has ranged, including the laying, from *one-fourth* to *three-fourths* of the cost of machinery.

Service Reservoirs.

These are now, by Act of Parliament, when situated near towns, necessarily covered by brick arches (supported on brick piers, or iron columns), or otherwise. The cost of these structures varies from 30s. to £3 per 1000 gallons of capacity. Those constructed with brick piers are rather less expensive than those in which the arches are supported on iron columns and girders. The cost of work of this kind almost always greatly decreases in proportion as it increases in extent. Thus, to construct a covered reservoir with iron columns, to contain 1,000,000 gallons, will be about £3,000, whereas one to contain 2,000,000 gallons will only be half as much again, or £4,500. If the arches be supported on brick piers, their prices are reduced to about £2,700 and £4,200 respectively. These estimates are made from average prices in the neighbourhood of London. Cast-iron reservoirs, with galvanized corrugated iron roofing, would, no doubt, in many situations, possess peculiar advantages, especially where the ground was porous, and brickwork expensive. These structures could probably be erected at the same cost as those of brick-work, with cast-iron supports for brick arches.

Filter Beds.

The cost of these structures ranges from 20s. to 30s. per square yard, each yard being able to filter about 500 gallons in twenty-four hours. The proportionate cost of filtering beds does not vary much as the beds get larger. A filter bed, to filter 1,500,000 gallons in twenty-four hours, costing (at average prices) about £ whereas one capable of doing just double the work will cost nearly double the price, or something like £

Before concluding this section, it should be observed that other engines and pumps, besides those above specified, have been employed for the raising of water for the supply of towns. These modifications in the designs of pumping machinery have been made with the view of somewhat lessening its cost, by constructing the engines as *double-acting* engines, moving at an increased speed, as also by making the pumps *double-acting*, that is, combined plunger and lift pumps. While the working of this class of machinery enables us to recommend it in case extreme economy is desirable, it must not be forgotten that greater rapidity of working can hardly fail in the long run to produce greater wear and tear, and especially where the machinery is intended, as in the above estimates, to work day and night.

It, however, is a question well worth the consideration of those requiring pumping machinery, whether they would prefer a single slow-working engine, calculated to work day and night, or two fast-working engines, each capable of doing the work of the slow one in the same time, allowing one always to remain idle in case of accident. The cost of machinery to work on either of these two principles would not be very different; if a single fast-working engine be adopted in place of the slow-working one, the cost would probably be only about two-thirds, the working expenses being, however, somewhat greater in the latter case.

Estimates of pumping engines and machinery of all descriptions will be furnished on application.

NOTE.—*Prices of the smaller sizes of high pressure pumping engines will be found under the head of Steam Pumps, Chap.* 13.

CHAP. XXII.—GAS WORKS AND APPARATUS.

COAL GAS APPARATUS.

It would be impossible, within the limits assigned in a Catalogue, even to so large and important a subject as Gas Works, to go fully into all the numerous considerations involved in their entire cost and establishment. The site, the area over which the lighting may ultimately extend, and the position of the works with regard to it, their proximity to the sources of supply of coal, and other materials employed in the manufacture, the quality of those materials, the length of mains, and their inclination, the dryness of the locality, and many other matters, have all to be carefully considered before any complete estimate for the erection of Gas Works can be made; but taking into account only such parts of the works as are actually employed in the manufacture, storage, and regulation of supply of the gas, and omitting all matters connected with its *distribution*, it will be possible to give an approximate estimate of the cost of Works of specific capabilities, the materials used being presumed to be of average quality.

In order to render the following estimates intelligible to non-professional readers, it will be well to state very shortly the processes of gas-making, and the apparatus required.

The processes are the following:—

1st. Carbonization of the coal, or its distillation, and the collection of the gas in the hydraulic main.
2nd. Purification of the gas, or all the changes it undergoes between the hydraulic main and the gas-holders.

For these operations the following apparatus is required:—

The carbonization of the coal is effected in iron, clay, or brick retorts, set in brick furnaces, each set being technically named "A BENCH." From the retorts it passes up the stand pipes, and descends the dip pipes, into what is called an hydraulic main. These parts constitute altogether the retort apparatus.

The purification of the gas is effected in various ways, according to the nature of the coal used, and the peculiar views of managers of gas works. In many works the gas is first *washed* in a "*washing vessel*;" then *scrubbed* in a "*scrubber*," *or* "*breeze condenser*;" thirdly, *cooled* in an "*air or water condenser*;" and, lastly, *purified* in a wet or dry "*lime purifier*."

The washing process is omitted in many works, and the scrubbing process in others, and in some works both these processes are omitted; the *cooling and purifying* processes being essential in every case.

Sometimes an intermediate process is adopted between the cooling and purifying processes—viz., passing the gas through a metallic salt, which must be done in a separate vessel lined with lead. The adoption of this process frees the gas from ammonia, and enables the dry lime purifying process to be employed instead of the *wet* one, the former being objectionable unless the gas has been previously freed from ammonia, but superior when that has been done.

It will thus be seen that the cost of gas apparatus depends to some considerable extent upon the processes purposed to be adopted in its manufacture, and the decision of the question as to which is best or most convenient can only be arrived at by professional men, after knowing the materials they have to deal with, and the ease or difficulty of obtaining them, &c.

The following estimates of the average cost of each part of the apparatus, retort houses, &c., *are reduced to the amount proportioned to a single retort* of the ordinary kind and dimensions, and capable of carbonizing 6 cwt. of coal in twenty-four hours, in six-hour charges of six half cwt. each, and from which about 2,400 cubic feet of gas may be obtained. In calculating the capabilities of any number of retorts erected in gas works, it must be borne in mind that nearly one-fourth of the retorts are always out of use; and consequently that the average production of gas from each retort in an establishment is only about 2,000 cubic feet in twenty-four hours, instead of 2,400, above given as the actual production. The estimates are therefore reduced to the proportional cost for each retort of the whole establishment, reckoning retorts both out of and in use.

Retorts and Fittings.

Price of *one cast-iron* retort, capable of making 2,500 cubic feet of gas in twenty-four hours, with mouth pieces, retort lids, ascension pipes, hydraulic main, floor-plates of retorts, pillars for carrying hydraulic main, furnace frames and ash-pit pans complete, but exclusive of setting and fixing, about £

Price of one earthenware retort, with all fittings of iron as above, and capable of generating the same amount of gas, but exclusive of setting or fixing, about £

If both iron and clay retorts be used and worked together (a very common arrangement), the average cost of each retort will be the mean of the above amounts—viz., about £

Tar Tanks.

These are of cast or wrought iron, or may be constructed of brickwork, roofed over.

They should be of capacity sufficient for six weeks' store of tar and ammoniacal liquor. As each ton of coal produces from 100 to 140 lbs. of tar, and from 10 to 13 imperial gallons of ammoniacal liquor, it follows that 100 cubic feet of capacity will be required in the tar tanks for each ton of coal carbonized in twenty-four hours.

The cost of tar tanks may therefore be estimated at an average for each retort erected in an establishment, and having a capacity of 25 cubic feet, or say 150 gallons, at about £

Condensing and Purifying Apparatus.

As the processes of "*washing and scrubbing*" the gas are not commonly adopted, except where great purity of gas is required, it will suffice if the cost be given of the apparatus *essential* in all cases where gas is manufactured from coal.

Condensers.

Condensers or coolers for gas are either vertical or horizontal, and consist of a rectangular box, containing a series of iron trays, or a series of upright pipes, connected at top and bottom. This range of pipes is usually 20 to 30 feet high, every 20,000 or 30,000 cubic feet of gas passing through in twenty-four hours requiring one pipe.

Sometimes the vertical condensers are made *annular*—that is, the gas passes between two pipes, air being allowed to circulate through the inner one, the outer pipe being 3 feet or upwards in diameter.

The price of condensing apparatus, of either of the kinds above described, may be safely estimated at an average for each retort erected in an establishment at from to

Purifiers.

Gas purifiers are constructed either for dry or wet lime. The former is simply an iron box containing trays of lime, over which the gas passes. The wet lime purifiers consist of an iron cylinder, with close top, through which passes a spindle, giving motion to a revolving arm or stirrer. The lime is introduced in a fluid state, and kept constantly agitated while the gas is passing through it.

The cost of purifiers, of either of the above descriptions, may be safely estimated, at an average for *each retort* erected in an establishment, from £ to £

Retort Houses.

The cost of retort houses will of course vary with the locality to a very great extent, but from several actual examples it has been found that plain houses, without coke sheds, but including chimney, may be erected for £ per retort; and if coke sheds and every part, including surrounding wall, be built in the most substantial manner, the cost seldom exceeds £ per retort.

Setting Retorts.

The average cost of setting either of the above retorts, and erecting the fittings, including all brick and concrete work, may be fairly estimated for each retort at £

Gas Holders.

The gas holder, as its name implies, simply serves as a depository or store for the gas after it is made, and should equal in capacity the maximum production of gas of the whole establishment during twenty-four hours, or, in other words, the quantity required for the longest winter night; where several gas holders are used, their *joint* capacity being made equal to this quantity.

Gas holders for regular gas establishments are made of various sizes, from those necessary for a single bench of retorts, containing 10,000 cubic feet, to those containing upwards of 1,000,000 cubic feet of gas.

The gas holder proper is constructed invariably of sheet iron, the tank in which it is placed, and which is filled with water, being made sometimes of cast iron, and sometimes of brickwork. The gas holder rises or falls in the tank as it becomes more, or less filled with gas, being balanced by weights suspended to chains passing over pulleys on the top of the pillars or standards, which act as guides, by which the gas holder is maintained in a vertical position.

The necessary pressure required to force the gas through the mains, is now generally obtained by a small regulating machine, acting quite independently of the gas holder, and thus obviating the necessity of increasing the pressure of the gas in the latter. In many provincial towns, however, the pressure still continues to be regulated by means of the weight of the gas holder itself.

The cost of gas holders cannot be given, as in the case of other parts of gas apparatus, at one uniform amount *per retort*, inasmuch as the greater the number of retorts used, the less in proportion will be the cost of gas holders, from their size being increased.

It is, however, possible to give the average cost of gas holders per retort, on the supposition that a given number of these are used :—

Cost of gas holder capable of holding 10,000 cubic feet of gas, and suited for works having one bench of five retorts, say £ or, per retort ... ... £

Cost of gas holder capable of holding 30,000 cubic feet of gas, and suited for works having three benches of five retorts each, say £ or, per retort ... ... £

Cost of gas holder capable of holding 150,000 cubic feet of gas, and suited for works having fifteen benches of five retorts each, say £ or, per retort ... ... £

Brick Tanks.

Where the foundation is tolerably good, brick tanks for gas holders may be constructed more cheaply than cast-iron tanks. Where, however, the foundation is not of the best description, they are best constructed of cast-iron plates bolted together.

The cost of brick tanks may be put down at the following figures, the brickwork being taken at about £11 per rod :—

Cost of brick tank for gas holder, to contain 10,000 cubic feet, about £ or, per retort ... ... £
Cost of brick tank for gas holder, to contain 30,000 cubic feet of gas, about £ or, per retort ... ... £
Cost of brick tank gas holder, to contain 150,000 cubic feet of gas, about £ or, per retort ... ... £

Cast-Iron Tanks.

The cost of cast-iron tanks will vary with the quality of castings and workmanship employed. The following estimates apply to the best work of this class :—

Cost of cast-iron tank, for gas holder, to contain 10,000 cubic feet of gas, about £ or, per retort ... £
Cost of cast-iron tank, for gas holder, to contain 30,000 cubic feet of gas, about £ or, per retort ... £
Cost of cast-iron tank, for gas holder, to contain 50,000 cubic feet of gas, about £ or, per retort ... £

Cast-Iron Main Pipes.

The following table gives the cost per yard of cast-iron Main Pipes, from 2 inches to 24 inches diameter, the estimate being based on a price of about £ per ton for pig iron. The pipes are calculated at $\frac{3}{8}$ in. thick for the 2-in. diameter, and $1\frac{1}{4}$ in. for the 24-in. diameter, the intermediate sizes being of proportional thicknesses.

Diameter of pipes, in inches.	2	3	4	5	6	7	8	9	10	12	14	16	18	20	24
Price per yard															

Elbows, bends, and special castings, are charged extra, except in large contracts.

Laying Mains.

The following table gives the approximate cost of laying one yard of from 2 inches to 24 inches diameter. The charge includes cost of lead for joints, carting, trenching, and laying the pipes.

Diameter of pipes, in inches.	2	3	4	5	6	7	8	9	10	12	14	16	18	20	24
Total cost of laying per yard ...															

COAL GAS WORKS.

In calculating the size of works required for any given consumption of gas, the following particulars must be borne in mind:—

1st. That only about four-fifths of the retorts will be in working order at any one time.

2nd. That the quantity of gas capable of being produced from each retort may be reckoned at 2,400 cubic feet in twenty-four hours for the number in *actual work*, or 2000 cubic feet for each of the *whole number* of retorts, which comes to about the same thing.

3rd. That the available quantity of gas for consumption must be reckoned at 10 per cent. less than the quantity actually made.

4th. That experience has shown that, taking this diminished quantity of gas, it will amply provide for the requirements of any town consuming that quantity in twenty-four hours in the *winter season*.

5th. That the quantity of gas consumed in twenty-four hours, in the winter season, is about 80 per cent. above the average daily consumption throughout the year; in other words, the average daily consumption throughout the year is about five-ninths of the daily consumption in the winter season.

For example—Suppose a town to consume 100,000 cubic feet of gas in twenty-four hours in the winter season, it would be necessary to erect gas works, making this quantity, plus 10 per cent. for losses, equal to 110,000 cubic feet in twenty-four hours, which, as above shown, would require fifty-five retorts, each making 2,000 cubic feet on the average, the number actually in work, say forty-four, making about 2,400 cubic feet each in the time, the gross make of such an establishment being on the average about 61,000 cubic feet per day, or a total of 22,300,000 cubic feet per annum.

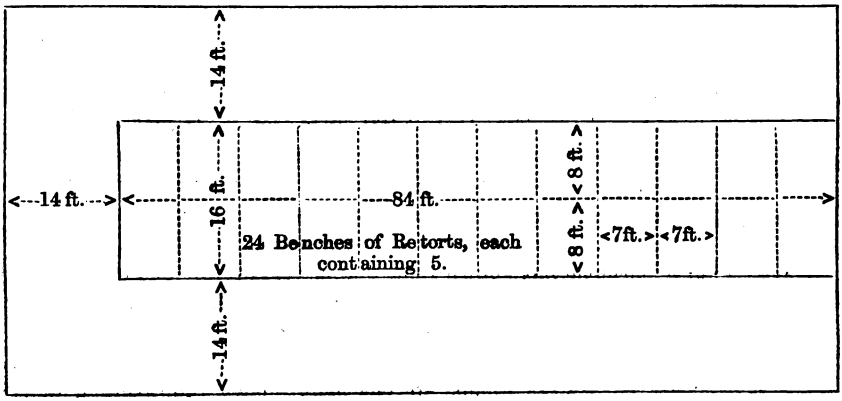
From the data above given, the approximate cost of any sized works may be arrived at, so far as the retort house, with retorts and fittings complete, are concerned.

To facilitate the calculation *of the size of house* required, it may be *stated that the best arrangement of retorts is where they are placed end to end*, and in

benches of five retorts each bench. Each single bench of retorts, such as *above described, would occupy* 8 feet across the house; or, two benches placed end to end, 16 feet across the house.

Thus, 120 retorts, making up twenty-four benches of five each, twelve benches being put on each side, would require a house 12 × 7 = 84 feet long, but to this should be added 14 feet to get round end of retorts, making 98 feet in all as the length of the retort house. As regards the width, we have the retorts occupying 16 feet in the centre of house, which, added to 14 feet along the front of each set of benches, gives 44 feet as the total breadth required.

The accompanying sketch will render this easily understood:—



The height of the firing floor should be about 8½ feet above the ground line, and the wall plate about 14 feet above the firing floor, making 22½ in all from ground line to wall plate.

The above estimate for retort houses is based on the supposition that brickwork is about 25s. per cubic yard, or about £14 per rod.

Observations on the Lighting of Towns.

In proposing to light a town, the first step will be to ascertain, as nearly as possible, the number both of private and public lights, the time they will burn, and the quantity each light will consume per hour. From these particulars the size of the works can be ascertained, and the cost approximately arrived at.

It may be usually assumed that the number of public lights will equal one-seventh of the number of private lights, and that all lights will consume about 5 cubic feet per hour. Also (in England), that the public lights will be lighted from sunset to sunrise, and the private ones from sunset to 9 p.m.

The greatest consumption in England is on or about the 21st December, when the night is 16¼ hours long, and the capability of the gas works must be equal to the greatest supply required. At the rate of consumption assumed above, the public lamps will then burn 81¼ feet each (16¼ × 5), and the private lights 25¾ cubic feet (5h. 9m. × 5), and from which the consumption of any number of lights may be calculated.

For example—Suppose it be required to light a town in which it was assumed 1,000 public lights would be required, then the private lights may be put down at 7,000.

The gas works must be able to make the greatest quantity, as above stated—viz., 81¼ feet for 1,000 public lights, = 81,250 cubic feet, and 25¾ cubic feet for 7,000 private lights=180,250 cubic feet, or a total of 261,500 cubic feet. To this we must add, say one-sixth leakage, which makes the total quantity 305,000 cubic feet.

If the charge for each retort be 2 cwt. of coal, making 9,200 feet of gas per ton, then eighteen benches of five retorts each would suffice, leaving one-tenth of the retorts out of use. The least capacity of gas holder for these works would be 125,000 cubic feet. These particulars differ somewhat from those before given, and are calculated for works where the Superintendent must take care to have nearly all the retorts in good working order in the winter season, otherwise twenty benches of retorts would be required.

Again, the size of gas holder here given is inconveniently small, and is in reality only half that formerly noted, but where economy is absolutely necessary, it is a proportion that may be employed. Of course, in this case, the gas must be continuously made as it is consumed, as a gas holder of this kind only contains about five hours' consumption.

TABLE showing the approximate Cost of GAS WORKS, complete, for Towns requiring from 100 to 1,000 Public Lights, and 700 to 7,000 Private Lights.

The Gas Holder of *maximum* capacity, and the Tank of Brickwork.

The Retort House with Coke Sheds complete.

No. of Public Lights.	No. of Private Lights.	Quantity of Gas required in Winter, for longest night.	No. of Retorts.	Cost of ditto, and Setting.	Tar Tanks.	Condensers.	Purifiers.	Gas Holder and Brick Tank.	Retort House.	Mains and Laying.	Public Lamps.	Sundries, including Meters, Valves, &c.	Total.
100	700												
250	1750												
500	3500												
750	5250												
1000	7000												

PORTABLE COAL GAS APPARATUS.

This economical and safe gas apparatus will be found of great value where regular gas works are wanting, and is well adapted for churches, factories, mansions, &c., &c. It is now ten years since it was first introduced to the public, and during that time some hundreds have been erected all over the world, and have given the greatest satisfaction. It is constructed on a very small scale, the whole not occupying more than a few feet square, and is so simple that a boy fourteen years of age can take the entire management of it. The material used for making gas is ordinary coal, the refuse coke from the retort in the larger apparatuses being sufficient to keep the retort heated. In the smaller apparatuses some extra coke will be required for this purpose. The gas produced is the ordinary carburetted hydrogen of the gas works.

The prices include retort and furnace, lime purifier, hydraulic dip, and gas holder, with standards, weights, pulleys, and chains, but exclusive of tank for gas holder, which is supposed to be of brickwork. A small brick pit is also required for the hydraulic dip.

	Price delivered in London.	Extra, if with Wrt.-iron Tank.
No. 1, adapted to light 15 burners	.....£	£
„ 2, „ 25 „	.....£	£
„ 3, „ 50 „	.....£	£
„ 4, „ 100 „	.....£	£
„ 5, „ 150 „	.....£	£
„ 6, „ 200 „	.....£	£

In these apparatuses it is intended that the gas should be made during the time it is being burned, consequently the gas holders are only calculated to contain *one-half* of the total quantity of gas consumed for the specified number of lights, each light being presumed to burn for four hours, and to consume 5 cubic feet of gas per hour.

Gas holders to contain a full night's supply may be had if preferred, at the following additional cost. The prices give the extra cost of gas holders, as well as iron tanks.

Sizes.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Extra cost of Gasometer to hold 1 night's supply... ...						
Cost of wrought Iron Tank for ditto						

GAS FITTINGS.

G. B. & Co. supply gas fittings of every description at the ordinary trade prices, whether for ordinary canal or Boghead coal or oil gas, the whole being arranged complete for any specified purpose.

For gas fittings it is impossible to give any very exact estimate, considering their great variety both in form and finish; but the following particulars may be a useful guide to those requiring to arrive at an approximate idea of the cost of fittings for either of the three classes of buildings required to be lighted, and noted in the following table.

The prices include bracket or pendant lights, burners, glass shades or chimneys, in the best class, but are exclusive of piping.

Suitable for what classes of Buildings.	For Factories and Warehouses.	For Shops, Offices, and Private Dwellings.	For Mansions, Public Buildings, &c.
Price *per light** ...	£	£	£

* The light here spoken of is one equivalent to a burner consuming 5 cubic feet of average coal gas per hour.

CHAP. XXV.—IRON VESSELS.

G. B. & Co. having had an extensive experience as Marine Engineers, are prepared to construct iron vessels of every description. At the Works they have a spacious iron ship-building yard, fitted up with every convenience for the speedy and efficient construction of iron steamers, ships, barges, &c.; and their study is to produce a thorough good vessel, at the lowest possible cost compatible with the use of the best material, and the employment of the most skilled workmanship.

The following is a list of some of the vessels and marine engines and boilers they have constructed within the last few years, viz.:—

Steamer "Gazelle," with engines and boilers of 80-horse power.
„ "Iris," „ „ 150 „
„ "Juno," „ „ 180 „
„ "Queen," „ „ 240 „
Engines and boilers of the celebrated Arctic discovery steamer "Fox."
„ „ steamer "Jersey," auxiliary, 30-horse power.
Iron schooner "Prince of Wales," 238 tons.
„ "Dee," 97 „
Two iron dredging boats, with engines and boilers of 40-horse power, and machinery complete, for the Egyptian Government.
Seven iron barges, for the conveyance of artillery, horses, and materials on the Nile, for the Egyptian Government.
Twenty sets of marine boilers from 15 to 400-horse power.

PADDLE TUG STEAMERS.

No. I.

An Iron Paddle Tug Steamer,

Of 20-horse power, not to draw more than 4 feet of water. A most useful boat for towing cargo boats to or from the ship's side to the beach.

Length	60 ft.
Breadth...	14 ,,
Depth	6 ,, 6 in.
Tonnage, O. M.	56 tons.

Fitted with one condensing engine of 20-horse power nominal, and one pole mast, but not fitted for a sea voyage. Delivered in the Thames, in pieces carefully marked for re-erection, with tools and materials for putting together abroad.

Price	£	sterling.
If fitted with *high-pressure* engines, about	£	,,
If fitted with masts, sails, and outfit complete for sea, delivered in the Thames *ready for sea* ... ... about	£	,,
If fitted with *two* condensing engines instead of one ... ... about	£	,,

No. II.

An Iron Paddle Tug Steamer,

Suited to tug five or six cargo boats, each capable of carrying 20 tons dead weight, on a river, with a draught of water not exceeding 2 ft. 6 in. laden. This forms a very suitable carrying plant for shallow rivers in tropical climates.

Length of Steamer	80 ft.
Breadth	16 „
Depth	6 „
Tonnage, O. M.	96 tons.

Fitted with a condensing engine of 30-horse power nominal; cylinder 30 in. diameter by 3 ft. 9 in. stroke; tubular boiler for ditto, and donkey steam pump; two cabins for captain and crew fitted with berths. All woodwork supplied complete in the usual manner. Delivered in the Thames, in pieces carefully marked for re-erection, with tools, rivets, and materials for putting together abroad.

Price ... ... £	sterling.
If without woodwork, such as decks, cabins, &c. ... ... about £	„
If with outfit for sea ... ... £	„

Price of the Iron Barges for ditto, 50 feet long by 16 feet broad by 4 feet deep, delivered in the Thames as above, but without woodwork or outfit, £ sterling.

No. III.

The following are the particulars of a very handsome and efficient

Iron Paddle Tug,

of 40-horse power nominal, supplied by G. B. & Co. to the Natal Government, for general harbour purposes at Port Natal.

To Class	A 1. 9 years.
Length	80 ft.
Breadth of Beam	18 ,,
Depth of Hold	9 ,, 6 in.
Draught, laden	7 ,, 0 ,,
Tonnage, O. M.	134 tons.

Fitted with a pair of marine condensing engines, 40-horse power collectively; cylinder 25 inches diameter, by 3 ft. 9 in. stroke; boiler tubular, and very strong, with 20 feet of heating surface to each horse power. The vessel fitted with two cabins; the after cabin for captain, neatly fitted and painted, with double bulkhead next to boiler; fore cabin painted and fitted with sleeping berths for crew. Outfit complete for sea. Anchors, chains, and warps, according to Lloyds'. Schooner rigged. Coal in bunkers 30 tons. Boat, engines, and outfit complete in the usual manner, of the best materials and workmanship. Delivered in the Thames ready for sea.

Price, £ sterling.

PADDLE PASSENGER STEAMERS.

No. I.

An Iron Passenger Steamer,

With spacious fore and after cabins, containing berths and accommodation for 16 first-class and 8 second-class passengers; and a hold with space for a limited quantity of light cargo.

Draught of water	about 2 ft. 6 in.
Length	110 ,,
Breadth	17 ,, 6 ,,
Depth	7 ,,
Tonnage, O. M....	163 tons.

Fitted with paddles and oscillating engines of 40-horse power nominal. Delivered in the Thames ready for sea. Boat, engines, and outfit complete, in the usual manner, and of the best material and workmanship.

Price, about £ sterling.

No. II.

A First-class Iron Clipper Paddle-wheel Steamer, for Passengers and Cargo.

Length over all	175 feet.
Breadth	20½ „
Depth of Hold...	10½ „
Gross register Tonnage	238·79 tons.
Draught of water, loaded	8 feet.

Average speed, about 14 miles per hour.

Average consumption of coals, about 13 cwt. per hour.

Fitted with oscillating engines of 100-horse power nominal, and donkey pumping engine. Bunkers to hold 30 tons of coal.

Quarter deck about 60 feet long, with break 18 inches deep. Top gallant forecastle. Water closets, &c., &c.

Passenger Arrangements.

Saloon, fitted with sofas, &c., suitable for 17 sleeping berths; small cabin adjoining, with 4 sleeping berths; gentlemen's sleeping cabin, with 8 berths.

Ladies' Cabin, 20 ft. by 12 ft., fitted with 14 berths.

Fore Cabin forward, with 16 berths; first-class small private cabin forward, with 2 berths; captain, mate, and engineers' cabin forward.

Large Steerage, fore part of fore cabin.

Capacity for Cargo, about 100 tons.

Boat, engines, and outfit complete, in the usual manner, of the best materials and workmanship. Delivered in the Thames ready for sea.

Price £ sterling.

No. III.

Specification of a First-class Iron Clipper Paddle-wheel Steamer of 40-horse power, for Passengers and Light Cargo.

Length...	120 feet.
Beam	17 „
Depth	7 „ 6 inches.
Tonnage, O. M.	170 „
Draught of water, loaded, not exceeding...	4 „
Average speed, about...	10 to 12 miles per hour.
Average consumption of coals, about ...	7 cwt. per hour.

To be fitted with first-class marine condensing engines, of 40-horse power nominal, and either 1 tubular or 2 flued boilers (the latter answer best for deck room); donkey pumping engine, &c., &c.

Handsome deck saloon, fitted with seats and table arrangements for first-class passengers—second and third class carried forward; (would carry about 200 first class, and 250 second and third class passengers.)

Horse-boxes on deck, and fittings for conveyance of carriages.

Cabins for captain, engineer, and crew below. Water-closets and other usual fittings in a first-class sea-going vessel.

Water-tight bulkheads.

Hold for light cargo.

Outfit complete for sea.

The boat, engines, and outfit complete, in the usual manner, and of the best materials and workmanship.

Price delivered in the Thames ready for sea, £

SCREW TUG STEAMERS.

No. I.

The following are the particulars of a most useful

Iron Screw Tug Steamer,

For passengers and cargo, similar to a vessel lately supplied by G. B. & Co. to be employed for the following purposes at Algoa Bay, viz. :—

1. To tug vessels in and out of harbour.
2. To load and unload ships in the bay.
3. To water ships in the bay.
4. To take out anchors to vessels in distress.
5. To carry passengers to and from ships in the bay, and to be capable of acting as a coasting steamer when required, carrying passengers and merchandize.

To class at Lloyds'	A 1. 9 years.
Length	120 ft.
Breadth	17 „ 6 in.
Depth	9 „ 6 „
Tonnage, O. M.	179 tons.
Draught, laden	7 ft.

Carrying capacity of hold, about 120 tons measurement.
Speed, about 9 knots per hour.

Fitted with a pair of direct-acting condensing engines of 40-horse power nominal; tubular boiler. Propeller to disconnect and allow the vessel to sail under canvas only. Donkey engine, and tanks to hold about 20 tons of fresh water, with hose, &c., for watering ships. A steam crane on deck for quick loading and unloading. After cabin fitted with berths or swing-back seats for 16 first-class passengers; fore cabin for 4 second-class ditto. Accommodation for crew. Schooner rigged, and outfit complete in the usual manner. Delivered in the Thames ready for sea.

Price £ sterling.

No. II.

A smaller vessel, similar to the above, to be employed for like purposes, but without passenger accommodation.

Length	100 ft.
Breadth	15 „
Depth	8 „ 6 in.
Tonnage, O. M.	108 tons.

Engines of 20-horse power. To carry 50 tons of cargo, and 20 tons of water in tanks, on a draught of 6 ft. 6 in. Rigged as a three-masted schooner. Delivered in the Thames ready for sea.

Price £ sterling.

SCREW CARGO VESSELS.

No. I.

An Iron Screw Steamer,

For river traffic only, suited to carry 50 tons dead weight, and 3 tons of coal, on a draught of 4 ft. 6 in. A very suitable boat for river or canal traffic.

Length	72 ft.
Breadth	12 ,, 6 in.
Depth of hold	5 ,,
Tonnage, O. M.	54 tons.

Fitted with a pair of high-pressure engines of 16-horse power, and tubular boilers. No masts or outfit. Delivered in the Thames.

Price £ sterling.

No. II.

An Iron Screw Steamer,

To carry 100 tons dead weight, besides fuel, on a draught of 6 feet water, at a speed of about 8 miles an hour. Very suitable for river or coasting traffic.

Length	100 ft.
Beam, moulded	15 ,, 6 in.
Depth of hold	7 ,,
Tonnage, O. M.	116 tons.

Fitted with a pair of steeple condensing engines of 20-horse power, and tubular boiler. Consumption of coal about 2½ cwt. per hour. Worked with a master, engineer, and two men on deck. Raised poop, and deck low amidships, to facilitate the getting in and out of cargo. Two long hatchways each 14 ft. long by 8 ft. 6 in. wide. Crane to lift two tons. Hold 50 feet long. A small cabin for master, and large forecastle for crew. Delivered in the Thames ready for sea.

Price £ sterling.

No. III.

An Iron Screw Steamer,

To carry 300 tons dead weight, at 10 feet draught of water, besides 50 tons of coals in bunkers. Average speed, about 8 knots per hour. Consumption of coal about 5½ cwt. per hour.

Length...	150 ft.
Breadth	20 „
Depth	12 „ 6 in.
To class at Lloyds'	A 1. 9 years.
Tonnage, O. M.	287 tons.

Fitted with engines of 40-horse power nominal. Delivered in the Thames with outfit complete for sea.

Price £ sterling.

No. IV.

An Iron Screw Brig,

To carry 430 tons dead weight, besides 60 tons of coal in bunkers, on a draught of 12 feet, at a speed of about 11 knots per hour.

Length	162 ft.
Breadth	23 „
Depth	13 „ 6 in.
Tonnage, O.M., 420; N.M., 343;	Reg., 267 tons.
To class at Lloyds'...	A 1. 12 years.

Fitted with direct-acting low-pressure engines of 70-horse power nominal; cylinder 30 inches diameter, stroke 27 inches; tubular boiler. Consumption of fuel, about 10 cwt. per hour. Cabin accommodation for 20 first-class passengers, and could be fitted for second. House on deck. Forecastle under main deck, and full poop. Outfit complete for sea. Rigged as a brig. Delivered in the Thames.

Price £ sterling.

No. V.

An Iron Screw Schooner Barque,

To carry 1000 tons dead weight, besides 100 tons of coal in bunkers, on a draught of 15 ft. 6 in.

Length for Tonnage	200 ft.
Breadth, extreme...	28 „ 2 in.
Depth of Hold, clear	17 „ 2 „
Tonnage, O. M.	800 tons.
To class at Lloyds'	A 1. for 9 years.

Fitted with direct acting engines of 120-horse power nominal, and tubular boiler. Consumption of fuel about 14 to 15 cwt. per hour. Delivered in the Thames ready for sea.

Price £ sterling.

IRON LIGHTERS OR BARGES.

Of all descriptions, for river or sea traffic. The following are some of the descriptions supplied by G. B. and Co.

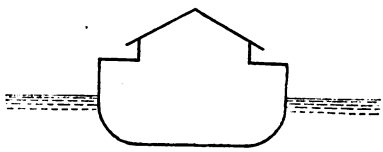
No. I.

A 15-Ton Iron Lighter,

For carrying cargo from the ship's side to the shore, fitted with a mast and 2 sails.

Length	50 ft.
Breadth	9 „ 6 in.
Depth	4 „ 6 „

The hull of $\frac{3}{16}$-inch plates riveted by $\frac{3}{8}$-inch rivets placed $1\frac{1}{2}$-inches from centre to centre. Plates overlap $1\frac{1}{2}$-inches, the ribs of angle-iron 2 × 2 inches, plates riveted to ribs by rivets 2 inches apart, the ribs placed 18 inches apart; the deck beams 2 × 2 inches; the rudder of $\frac{3}{16}$-inch plates, 5 feet wide, jointed to stern by eyes and long bolts; the tiller of iron. Fore and aft a small hatch to give access to watertight compartments. The lighter inside and out painted with two coats of patent anti-corrosive paint. A mast and two sails. The coverings to protect cargo are of wood. A section would appear thus—



A supply of bolts, rivets, and materials for putting together abroad. The whole erected and fitted together here,—each piece being carefully marked for re-erection abroad. Packed for shipment.

Price, delivered in pieces in London, £ sterling.

No. II.

An Iron Lighter,

Of 15 to 20 tons, for river traffic, strongly built, fitted with 2-inch pine decks, no cabin, one mast, and two sails.

Length	30 ft.
Breadth	12 ,,
Depth	5 ,,

Delivered in the Thames, in pieces carefully marked for re-erection, with tools and materials for putting together abroad.

Price, £ sterling.

No. III.

An Iron Surf Boat,

Same as above, but constructed to carry 25 tons of sugar along a sea coast, and sail well on a draught not exceeding 3 feet 3 inches; same as supplied by G. B. & Co. to A. Coqui, Esq., Natal.

Length	42 ft.
Breadth	15 ,, 6 in.
Depth	5 ,, 0 ,,

Made very strong to go on the beach, double riveted throughout—fitted with a sliding keel contained in a water-tight trunk. Schooner-rigged, cabin for four men, and outfit complete for sea. Delivered in London, in pieces, all carefully marked for re-erection, with tools and materials for putting together abroad.

Price, £ sterling.

N.B.—If the draught of water could be increased to 4 @ 5 feet, the cost would be considerably less.

No. IV.

An Iron Screw Surf Boat,

To carry the same weight on the same light draught as above, made 75 feet long, by 14 feet broad, by 6 feet deep, fitted with engine and boiler complete, would cost about £ sterling, delivered, &c., as above.

N.B.—If the draught of water could be increased to 4 @ 5 feet, the cost would be considerably less.

CHAP. XVIII.—RAILWAY PLANT.

G. B. & Co. are contractors for the supply of all descriptions of railway plant, and their experience in designing and supplying this class of machinery enables them to furnish the same, of the most approved construction, at moderate prices. Their most recent order of this nature was for the Port Natal Railway, South Africa; and G. B. & Co. have had the pleasure to receive the Directors' flattering approval of the satisfactory manner in which their contract had been fulfilled.

Under the following heads, viz.:—

CONTRACTORS' PLANT,
PERMANENT WAY MATERIALS,
ROLLING STOCK, including Locomotives,
RAILWAY SIGNALS,

Will be found descriptions of the more important articles they have been in the habit of supplying for railways abroad, with the approximate prices of each delivered in London. The gauge of the railway being assumed in all cases as that of the English narrow gauge, viz., 4 ft. 8½ in.

CONTRACTORS' PLANT.

The following is a list of the plant required in making a colonial line, of from 50 to 100 miles; the value of the plant would vary from £ to £ , according to the nature of the country.

10 iron wedges, assorted.
100 crowbars, steeled at both ends.
50 best steel borers, 18 inches.
5 double pumps.
25 single pumps.
50 sledge hammers.
100 hand hammers, wedge, and adjusting.
10 crabs—5 single, 5 double.
10 sets of metal blocks, and hemp falls, assorted.
10 patent screw jacks.
4 travelling twisting machines.
100 picks, light pattern.
100 shovels, light pattern.
10 sets of boring tackle.
4 portable engines.
10 portable smith's forges.
100 barrows.
100 earth waggons.
200 tons of Contractor's rails.
10 sets of carpenters' tools.
100 pile screws.
1 set of stone quarrying tools.
1 sleeper cutting and shaping machine.
2 sets of saw-mill apparatus, and gearing.
1 wood preserving apparatus, tank, hydraulic press, &c., complete.
3 sets of assorted circular saws, bands, and gearing.
2 grindstones.
10 tons assorted chains, slings, &c.
3 tons assorted bolts, spikes, and wood screws.
3 locomotive engines.
3 sets of spare parts for ditto.
4 brick machines.
100 sets of bricklayers' and masons' tools.
20 tons assorted flat, square, and round iron.
1 ton assorted steel.
2 lathes.
Coke.
Pug, mortar, and cement mills.

Rammers, levels, chisels, squares, iron chasers, adjusting mallets, anvils, levers for raising rails, guages for adjusting chairs.

Hand instruments obtained on the spot, of form, size, and weight, in general use.

The cost of the following tools required by one gang of plate-layers is about £ to £

1 wood hammer, iron bound.
1 set of levels—viz., 2 red, 2 black, 1 white.
4 pickets, shod to receive levels.
2 wooden rules.
1 wooden lever, shod.
1 claw crow bar for dressing rails, about 90 lbs.
1 crow bar for dressing way, 44 lbs.
1 iron hammer for keying, 9 lbs.
1 iron gauge for setting out width of way.
1 hand hammer.
1 auger.
1 tool marker.

PERMANENT WAY MATERIAL.

Rails.

The following are the most approved sections:—

"Contractors" or "American" section, weighing 14 lbs. to 40 lbs. per yard, suitable for contractors' use, or lines with very light traffic.

"Bridge Section," weighing 14 lbs. to 66 lbs. per yard, suitable for tramways and main lines, with longitudinal sleepers.

"Double headed" section, weighing 52 lbs. to 85 lbs. per yard, suitable for main lines, with light and heavy traffic. This section is in most general use.

Price of the above, delivered in London, from £ to £ per ton, according to the section.

The subjoined list will be found useful in calculating the weight of rails required for a line.

Total Weight of Rails for a Single Way, per mile length.

Weight per yard.	Total weight per mile.				Weight per yard.	Total weight per mile.				Weight per yard.	Total weight per mile.			
Lbs.	Tons.	cwts.	qrs.	lbs.	Lbs.	Tons.	cwts.	qrs.	lbs.	Lbs.	Tons.	cwts.	qrs.	lbs.
30	47	2	3	12	47	73	17	0	16	64	100	11	1	20
31	48	14	1	4	48	75	8	2	8	65	102	2	3	12
32	50	5	2	24	49	77	0	0	0	66	103	14	1	4
33	51	17	0	16	50	78	11	1	20	67	105	5	2	24
34	53	8	2	8	51	80	2	3	12	68	106	17	0	16
35	55	0	0	0	52	81	14	1	4	69	108	8	2	8
36	56	11	1	20	53	83	5	2	24	70	110	0	0	0
37	58	2	3	12	54	84	17	0	16	71	111	11	1	20
38	59	14	1	4	55	86	8	2	8	72	113	2	3	12
39	61	5	2	24	56	88	0	0	0	73	114	14	1	4
40	62	17	0	16	57	89	11	1	20	74	116	5	2	24
41	64	8	2	8	58	91	2	3	12	75	117	17	0	16
42	66	0	0	0	59	92	14	1	4	76	119	8	2	8
43	67	11	1	20	60	94	5	2	24	77	121	0	0	0
44	69	2	3	12	61	95	17	0	16	78	122	11	1	20
45	70	14	1	4	62	97	8	2	8	79	124	2	3	12
46	72	5	2	24	63	99	0	0	0	80	125	14	1	4

Chairs.

The descriptions in general use are the following:—

"Common chair," in which the rail is secured by means of a compressed wooden wedge; the chair being held down to the wooden sleeper by iron spikes.

Price, delivered in London, £ per ton.

The list given below will be of assistance in calculating the amount of chairs requisite for any given length of line.

CHAIRS, NUMBER REQUIRED, AND TOTAL WEIGHT PER MILE LENGTH OF SINGLE WAY.

Weight of each chair.	Bearing, 2ft. 6in. No. of chairs, 4224.			Bearing, 3ft. 0in. No. of chairs, 3520.			Bearing, 3ft. 6in. No. of chairs, 3017.			Bearing, 3ft. 9in. No. of chairs, 2816.			Bearing, 4ft. 0in. No. of chairs, 2640.		
	Tons.	cwt.	qrs.	Tons.	cwt.	qrs.	Tons.	cwt.	qrs.	Tons.	cwt.	qrs.	Tons.	cwt.	qrs.
15	28	5	2	23	11	1	20	3	4	18	17	0	17	13	2
16	30	3	1	25	2	3	21	11	0	20	2	1	18	17	0
17	32	1	0	26	14	1	22	17	3	21	7	1	20	0	2
18	33	18	3	28	5	2	24	4	3	22	12	2	21	4	1
19	35	16	2	29	17	0	25	11	8	23	17	2	22	7	3
20	37	14	1	31	8	2	26	18	3	25	2	3	23	11	1
21	39	12	0	33	0	0	28	5	2	26	8	0	24	15	0
22	41	9	2	34	11	1	29	12	2	27	13	0	25	18	2
23	43	7	1	36	2	3	30	19	2	28	18	1	27	2	0
24	45	5	0	37	14	1	36	6	2	30	3	1	28	5	2
25	47	2	3	39	5	2	33	13	1	31	8	2	29	9	1
26	49	0	2	40	17	0	35	0	1	32	13	2	30	12	3
27	50	18	1	42	8	2	36	7	1	33	18	3	31	16	1
28	52	16	0	44	0	0	37	14	1	35	4	0	33	0	0
29	54	13	2	45	11	1	39	1	0	36	9	0	34	3	2
30	56	11	1	47	2	3	40	8	0	37	14	1	35	7	0

Patent cast iron bowl chair and sleeper combined, suitable for tropical countries, and requiring no wooden sleeper. This chair is largely used in Egypt and India.

Price of the above per ton ... ... £
Tie rods for ditto, per ton ... ... £
Gibs end cotters for ditto, per ton ... ... £
Wrought-iron fish plates, for joining the ends of the rails, per ton ... ... £
Fish-plate bolts, per ton ... ... £
Compressed oak wedges, per 1000 ... ... £
Dog-headed spikes, for contractors' rails, per ton ... ... £
Switches, points, and crossings, per set ... ... £

Turntables.

Ordinary 13 feet cast-iron turntables, for goods, waggons, &c., to carry 10 tons each ... ... £
13 feet wrought iron ditto, to carry 10 tons ... ... £
16 feet wrought iron ditto, for main road, to carry 20 tons. £
20 feet wrought iron ditto, to carry 25 tons ... ... £
40 feet wrought iron ditto, to carry 45 tons ... ... £
Other sizes in proportion.

Carriage Traversers.

For removing carriages or waggons from one line of rails to another without disturbing the permanent way, made of wrought iron, strong and light ... ... each £

Weighing Machines.

Small portable machine, to weigh up to 5 cwt., for use at stations, fitted with wheels ... ... each £
Machine for Waggons, &c., to weigh up to 12 tons, with weigh pillar, &c., complete ... ... each £

Water Cranes.

Water crane, with fixed pillar for leather hose ... ... each £

Water crane, with revolving swan neck and stop valve, opened from top of tender ... ... each £

Water crane, with revolving swan neck, and stand pipe for lifting stop valve placed on the bed plate ... ... each £

PUMPS and TANKS, for supplying water cranes of any size, of wrought and cast iron. The following hand, cattle, and steam pumps, are suitable for this, and also for general purposes.

Hand-Pumping Engine.

Consisting of a 3½ *double* barrel brass pump, with fly wheel, 5 feet in diameter; brass couplings, handles, and improved kite motion, and copper air vessel complete; mounted on a strong cast-iron frame, adapted to be placed over the mouth of a well, ready to have piping attached ... ... each £

This hand engine has been selected by the Great Indian Peninsular and other Railway Companies, and is now extensively used as a most effective machine for pumping water from wells, for the supply of locomotives, railway stations, and other buildings. It is capable of raising about 20 gallons per minute from a depth of 30 feet, and will be found very useful in forcing water to considerable distances when required.

The following smaller size is also made—viz., with a *single* 3½ in. brass pump, capable of raising about 10 gallons per minute, with copper, air vessel, &c., complete ... each £

Foot valves for the above, necessary for depths above 20 feet.

Cattle-Pumping Engine.

This engine consists of a strong circular cast-iron frame, bolted to the mouth of a well, and fitted with swivel yoke for one animal, level, wheel, and pinion, double throw crank, slings, and guides complete. Also, two full way 4 in. double barrelled deep-well pumps, with valves, fitted with moveable doors; recommended for the great facility with which the valves can be repaired or cleaned without removing the pump.

Price complete, ready to have the piping attached ... ... £

For prices of wrought iron piping, suitable for these pumps, *see* Chapter 28.

Steam Pumping Engine.

With Cast-iron Tank.

This powerful apparatus consists of a high-pressure steam pumping engine and boiler, with all necessary mountings complete, capable of pumping 1200 gallons of water per hour. The engine is placed over the well, and connected by means of suitable piping with a tank on the top of the engine-house, capable of holding gallons. The whole fitted, with piping and valves complete, within the walls of the engine-house, ready to be erected and set to work.

Price ..... £

Fencing.

For prices and particulars of iron fencing, *see* Chapter 4.

Cranes

For various purposes, and of various strengths; for prices and particulars of which *see* Chapter 14.

ROLLING STOCK.

Locomotive Engines.

The following classes of locomotives are recommended for the several purposes named, and will be found to suit the requirements of most lines; other classes can be supplied for lines where the traffic or requirements are of a special nature. The engines named are intended in all cases for the English narrow gauge of 4 feet 8½ in.; and the prices include packing for shipment and delivery in London.

Small Mineral Tank Engine,

With all the four wheels coupled, suitable for tramways, and colliery lines, &c.

This handy little engine will draw a load of 80 tons on a level (exclusive of its own weight), and is much used by colliery proprietors, stone quarrymen, and others, in this country, instead of horse power. The feed water sufficient for a short run is held in a tank over the boiler, and the fuel in iron boxes at the sides of the foot-plate. The fire box is adapted to burn either wood or coal.

Price ..... £

Four wheeled Tank Engine,

With outside cylinders, and all the wheels coupled, very suitable for light goods or passenger traffic on short branch or Colonial lines.

This engine is similar to that supplied by G. B. & Co. for the Natal Railway, South Africa, which has given very great satisfaction. It is capable of drawing a load of about 120 tons on a level, and is suited to burn either wood or coal. The tanks contain sufficient water and fuel for a trip of five miles, and a powerful break acts upon all the wheels. The engine is fitted with all the most approved modern appliances, including a steam pump for supplying the boiler when the engine is standing, and awning to protect the driver.

Price ..... £

G. B. & Co. supply a ballast engine for contractors' use, similar to the above, but finished *black*. Price about per cent. less.

Six wheeled Tank Engine,

With inside cylinders, and the centre and hind wheels coupled, admirably suited for ordinary passenger or light goods traffic, on lines from 10 to 20 miles in length.

It is capable of drawing a load of about 200 tons, on a level, at miles per hour, and is suited to burn either wood or coal. The tanks contain

water and fuel sufficient for a trip of about 10 miles, and a powerful break acts on each side of the four driving wheels. This engine is fitted with an awning to protect the driver, and in all respects in a first-class manner.

Price ..... £

Six wheeled Passenger Engine and Tender,

Similar to those in use on the Midland, London and Brighton, and other English lines; with inside cylinders, and a single pair of driving wheels, capable of drawing a load of 240 tons, on a level, at a speed of 25 miles per hour; the whole fitted in a first-class manner, with copper fire-box, suited to burn either wood or coal. The tender, on six wheels, fitted with powerful break; to carry 1200 gallons of water, and a proportionate quantity of fuel.

Price ..... £

Four wheels coupled Passenger Engine and Tender,

For heavy passenger traffic, as used on many of the principal English lines, with inside cylinders, and the centre and hind wheels coupled; capable of drawing a load of 285 tons, on a level, at a speed of 25 miles per hour. The fire-box adapted to burn either wood or coal. Six-wheeled Tender, fitted with powerful break, to carry 1200 gallons of water, and a proportionate quantity of fuel. The whole fitted in a first-class manner.

Price ..... £

Four wheels coupled Goods Engine and Tender,

For ordinary goods traffic, or for mixed goods and passenger trains, with inside cylinders, and the leading and centre wheels coupled, capable of drawing a load of 300 tons, on a level, at a speed of 15 miles per hour. Six-wheeled tender, fitted with powerful break, to carry 1200 gallons of water, and a proportionate quantity of fuel.

Six wheels coupled Goods Engine and Tender,

For heavy goods traffic, similar to those in use on the Great Northern Railway, and other English lines. Inside cylinders, and all the six wheels coupled, capable of drawing a load of 350 tons, on a level, at a speed of 15 miles per hour. The fire-box suited to burn either wood or coal. Six wheeled tender, with powerful screw break, to carry 1500 gallons of water, and a proportionate quantity of fuel. The whole finished in the most complete manner.

Price ..... £

CARRIAGES.

First-class Carriage.

To accommodate from 18 to 30 passengers, fitted with cushions or cane seats if preferred. The under-frame constructed of oak, and the body of teak varnished, with steel suspension and buffer springs; special provision made for ventilation, so as to adapt the carriage for use in a tropical country. The whole finished complete in the best style.

Price, from £ to £

Second-class Carriage.

Similar to the above, but adapted for second-class passengers, to seat from 24 to 48 persons; fitted with cane seats or cushions.

Price, from £ to £

Composite Carriage.

Containing one or two compartments for first class, and the remainder for second class. Prices in proportion to the relative number of compartments of each class.

Third-Class Carriage.

Without roof, fitted with wood seats, to accommodate from 24 to 48 passengers. The under-frame, springs, &c., similar to the first-class carriage before described.

Price, from £ to £

Price of ditto, if with roof, supported on iron pillars, and open sides.

From £ to £

Price of ditto, if with closed sides and roof, similar to second class.

From £ to £

Extra if the carriages are fitted with powerful break to all the wheels.

£ each.

Luggage Van.

Fitted up for the conveyance of passengers' luggage; the under-frame, body, &c., the same as for the carriages.

Price, from £ to £

Price of ditto, if with a guard's compartment, and fitted with a powerful break,

From £ to £

Improved Screw Couplings,

For carriages made of best iron.

Price, £ each.

WAGGONS.

Closed Goods Waggon.

For dry goods and general merchandize, fitted with a door at each side. The under-frame of oak, body of pine, all painted; dead buffers, steel suspension springs, wrought iron wheels and axles, strong draw hooks, and chains, &c., complete.

The following are some other descriptions of goods waggons, viz.:—

HIGH-SIDED WAGGON, to carry 6 tons each, from £ to £
„ „ 8 tons each, from £ to £
„ „ 10 tons each, from £ to £

LOW-SIDED WAGGON, with sides, from 12 in. to 24 in. high, either all fixed or with two sides or two ends fitted on hinges, so as to fall down; very suitable for all kinds of heavy goods, including sugar hogsheads:— To carry 6 tons each, from £ to £
„ 8 tons each, from £ to £
„ 10 tons each, from £ to £

Timber Waggon.

For carrying long balks of timber; fitted with swivel, block, &c. The under-frame, &c., the same as for goods waggons.

Price, from £ to £

Coal Waggon.

Specially adapted for the conveyance of coal, lime, &c., and fitted with hopper door, and catch for discharging the load underneath the waggon. Under-frame, &c., the same as for goods waggons.

To carry 6 tons each, from £ to £
„ 8 tons each, from £ to £
„ 10 tons each, from £ to £

Horse Boxes.

For the conveyance of horses, with under-frame, &c., the same as for goods waggons.

Price, from £ to £

Cattle and Sheep Trucks.

Specially suited for the conveyance of these animals. The under-frame, &c., the same as for goods waggons.

Price, from £ to £

Other kinds of waggons designed and supplied for special purposes.

Extra if any of the before-named waggons are fitted with steel spring buffers.

£ each.

Ditto, if fitted with lever breaks, £ each.

Contractors' Earth Waggons.

One of the cheapest and most useful description of contractors' earth waggons is shown in the annexed sketch. The under-frame being of oak, body of red pine; cast iron wheels and wrought iron axles.

Price, from £ to £

RAILWAY SIGNALS.

Patent Semaphore Railway Signals.

These are now used by all the principal Railway Companies in Great Britain. They are so arranged that the changes of position in the lights and arms of the signal are made simultaneously, thus avoiding any possibility of error.

Single post signal, with single semaphore lamp, and iron work complete ... ... £

Single post signal, with double semaphore, and suitable lamp, &c. ... ... £

Single post signal, with ladder, balcony, &c. ... ... £

For Electric Telegraphs, *see* chap. 20.

SUMMARY.

The following summary of the Permanent Way Materials, Rolling Stock, and Tools and Machinery necessary in making and working a line of say 50 miles in length, may be of service in calculating the total cost of such a line.

Approximate Cost of the Permanent Way Materials.

	£	s.	d.
Rails, lbs. per yard, *per mile*, tons, @ £ per ton			
Patent cast-iron bowl-chairs, consisting of chair and sleeper combined, and requiring no wooden sleeper; very suitable for tropical climates; per mile tons, @ £ per ton			
Wrought iron tie rods for connecting the above chairs; per mile, tons, @ £ per ton			
Wrought iron gibs and cotters for ditto; per mile, cwt. @ £ per cwt.			
Wrought iron fish plates, for joining the ends of the rails: per mile, tons, @ £ per ton...			
Fishplate bolts for fastening ditto; per mile, cwt., @ £ per cwt.			
Compressed oak wedges, for wedging the rails to the chairs; per mile, @ per 1000			
Switches, points, and crossings, say per mile			
Waggon and engine turntables and carriage traversers, proportion per mile			
Water tanks, water cranes, and pumps, proportion per mile			
Signals, lamps, &c., proportion per mile			
Total per mile ... ... £			

In addition to the plant enumerated above, the following iron work would also be required; the cost of which would of course depend upon the requirements of the intended line of railway:—

STATIONS AND SHEDS.—For prices of galvanized iron buildings, *see* Chap. 4.

FENCING.—For prices of the several kinds of iron fencing, *see* Chap. 4.

BRIDGES.—For prices of iron bridges, *see* Chap. 23.

GAS WORKS, for Stations.—For prices, *see* Chap. 22.

ELECTRIC TELEGRAPH.—For prices, *see* Chap. 20.

Approximate Cost of the Rolling Stock for an average traffic on a line of 50 miles.

			£	s.	d.
16	locomotive engines and tenders,	@ £ each...			
10	first-class carriages	@ £ „ ...			
20	second-class carriages	@ £ „ ...			
50	third-class carriages	@ £ „ ...			
8	break vans	@ £ „ ...			
50	goods waggons	@ £ „ ...			
50	coal waggons	@ £ „ ...			
10	cattle and sheep waggons	@ £ „ ...			
10	timber trucks	@ £ „ ...			
5	horse boxes	@ £ „ ...			
5	carriage trucks	@ £ „ ...			
6	break vans	@ £ „ ...			
		Total ... ... £			

LOCOMOTIVE, CARRIAGE, AND WAGGON REPAIRING SHOP.

The following memorandum shows the tools and machinery required for the repairing shop of a railway 50 to 100 miles long. For shorter lines, of course a much smaller establishment will suffice.

High-pressure engine, 20-horse power.
2 boilers.
Mountings.
Wrought and cast-iron shafting.
Couplings.
Keys, bolts, and nuts.
Bevel wheels (morticed).
Wall boxes, pedestals, brackets, &c.
Hangers.
Pulleys.
Brasses.

Ground Floor.

Lathe for turning up locomotive wheels, keyed on their axles.
Large lathe for general use.
4 slide lathes, 14 inch head stocks, 18 feet beds.
1 screwing ditto ditto
2 double pillar drills, back geared.
2 portable drills.
3 wall drills, rising tables.
2 nut shaping machines.
2 large lever planing machines.
2 5-inch slotting machines.
planing machines, 6 feet
1 ditto, 10 feet
Slotting machine, 12-inch stroke
Slotting machine for slotting locomotive driving wheels, paring cranks, &c.
1 horizontal boring machine, with two boring bars.
2 large bolt screwing machines.
1 punching machine.
1 shearing machine.
2 grindstones and frames.
1 fan.
1 25-cwt. steam hammer, with anvil, &c., complete.

1 10-cwt. steam hammer, with anvil, &c., complete.
2 forge furnaces and chimney mountings.
2 1-ton cranes.
2 large smithy fires, anvils, and other tools for ditto.
12 small ditto ditto.
24 vices for fitters, and 4 for smithy.
Cupola, with stage, staves, &c.
Iron work for brass furnace.

Second Floor.

2 slide lathes, 14-inch head stocks, 18 feet beds.
2 ditto, 12-inch ditto ditto.
1 screwing lathe, 10-inch ditto ditto.
1 slide lathe, 10-inch ditto ditto.
2 pair of lathes, 10-inch ditto, beds and slide rests.
2 small bolt screwing machines.
4 small lever planing machines.
2 5-inch slotting machines.
4 foot lathes.
2 portable drills.
2 circular saws, cast-iron beds, planed.
2 grindstones and frames.
1 crane to lift a ton.
2 cranes to lift 2 tons each.

Cost of above from £ to £ , delivered in London or Liverpool.

For description and prices of machine, tools, and foundry fittings, &c., *see* Chapter 5.

RULE FOR CALCULATING THE TONNAGE OF VESSELS.

In order to arrive at the approximate cost of vessels of different sizes from the prices before given for each *ton*, according to builder's measurement, and for each *nominal horse power* of engine, it will be necessary to ascertain the tonnage of the vessels, and the amount of power necessary to propel them at the speed desired.

To do this with *absolute accuracy* requires much time and care, and involves considerations with which non-professional men cannot be presumed to be familiar. The following rules, however, will enable any one, with little calculation, to arrive at approximate prices of vessels, and which will be quite near enough to their actual cost to enable those requiring them to determine upon the advisability, or otherwise, of employing them.

Builder's tonnage is found by multiplying the length* of the vessel, less three-fifths of the beam, by the beam,† and this again by half the beam, dividing the product by 94.

Thus, a vessel 100 feet long and 20 feet broad, would measure by builder's measurement $187\frac{23}{94}$ tons (*i.e.*, $\frac{100 - 12 \times 20 \times 10}{94} = 187\frac{23}{94}$). This calculation, although correct for what is called the builder's tonnage, does not always fairly represent the capacity of the vessel, as the *depth* is assumed to be equal to *half* the beam; but, as in most cases a vessel 20 feet beam would now be made 12 feet deep, the builder's measurement does not represent the actual carrying capacity of such vessel. It will, therefore, be necessary to add something to the tonnage found by the foregoing rule, which may be done as follows:—Multiply the length of the vessel by the breadth of the beam, and again by the excess of the depth of the vessel above half the beam; divide this product by 60, and add the quotient to the tonnage before found. This will give the total tonnage upon which the cost may be based.

In the example before given (supposing the vessel to be 12 feet deep) the addition would be thus found:—Multiply 100 (the length of the vessel) by 20 (the beam) and then by 2 (the excess of 12, the depth, above the half-

* The length of the vessel should be taken at the half-depth between gunwale and keel, thus allowing for rake of stem.

† The beam is the greatest width of vessel amidships.

beam), and divide by 60. This will give 66 tons, which, added to, say 188 tons, gives 254 tons as the total.

The most approved proportions for steam vessels range in length from between 5 to 6½ times the beam; the depth of hold being equal to from ½ to ⅓ of the beam. In steamers designed for towing vessels, the least of these proportions may be conveniently adopted, as it is desirable to make them so as to be easily turned round.

As regards the proportion of power to tonnage, it is calculated that a full-powered paddle boat requires 1 nominal horse power to every 2 or 3 tons of the vessel, but in screw boats the proportion is 1 nominal horse power to every 4 or 7 tons of the vessel; the former proportion being adopted for many passenger or mail boats, and the latter for all cargo vessels; the former making from 9 to 12 knots per hour, and the latter about 7 knots. In these calculations the engines are presumed to work up to about 3 times their nominal power, which most good marine engines do.